HALF HOURS IN THE TINY WORLD

Harry A. Gibson

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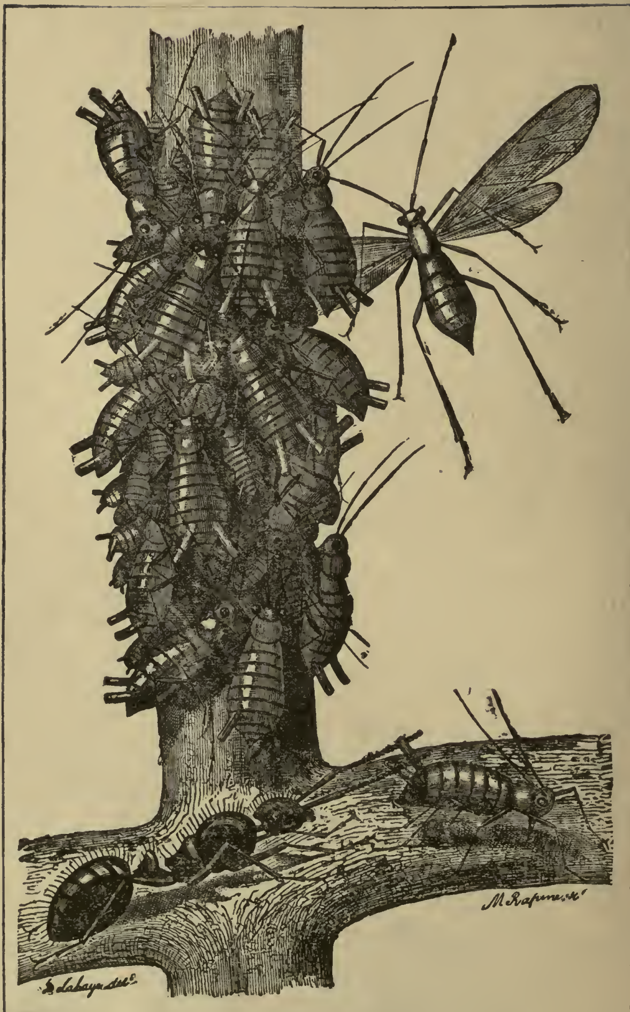

APHIDES.

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HALF HOURS IN THE TINY WORLD

Wonders of Insect Life

WITH NUMEROUS ILLUSTRATIONS

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ILLUSTRATIONS.

ABOUT A CATERPILLAR

ABOUT A CATERPILLAR.

"I'D be a butterfly, happy and gay!" But who, if he could help it, would be a caterpillar?

And yet, as an old saying hath it, "We must creep before we can go. We must walk before we can fly." A decree significant of the beginnings and endings of more lives than are dreamed of in the philosophy of creeping things in general.

Look at the crawling, munching creature, contented and happy enough, satisfied with its lot, while that lot is cast on a good large cabbage-leaf, or, with hundreds of its fellows, swarming on the leaves of a young gooseberry-tree, or a field of turnips,—repulsive being! its very contentment is revolting: we would fain inspire it with a few sentiments of a more exalted nature, and give it something to exist for; some object to sigh, to struggle for, and in vain to grasp.

Yet what longings, what vain ambitions can ever equal

the real future that lies before this despised being? whose life yet is unvaried by dreams of airy flight, or by any anticipations of his future; when he shall leave his present lowly condition to soar far beyond his present ken, mounting aloft on rapid wing, or balanced for a

CATERPILLAR, CHRYSALIS, AND BUTTERFLY.

moment on the fair cup of the flower whose nectar he sips in passing, in place of now slowly munching the leaves, or sleeping on the remains of his heavy repast.

For the present, to eat and to sleep seems to be the lot of these poor crawlers. But look within. *There* is

far more than meets the eye. Beneath that mean form, its gaudy exterior, and strange appendages of legs, of scales, and of teeth, a process is being carried on, a formation completing, a perfection advancing, contrasted marvellously with its exterior existence, and yet growing out of it, sustained by and assimilated from diet of the most unlikely kind—by cabbage-leaf, disintegrated by a course of equal marches round its narrowing edge by the creature whose rapacious tooth devours every inch that its feet can tread; by potato-field ravaged by the invading myriads, or the leaf and root of the forest tree.

Yes, the future *imago* is forming now; days of monotonous toil, of diligent accretion, of patient preparation, and of tedious torpor in the antechamber of mortality, shall result in that lovely winged thing, that shall float on the zephyr, and glitter in the noonday light: the wings, the antennæ, the exquisite plumage of various hues, the inconceivable lightness of the freight they bear, all wondrously contrasting with the form they left behind: and surely, if colour, like sound, have its various waves and notes, that thing of beauty shall waft a song of praise to heaven with every movement of its wings.

Ah, yes! like that, and something more—not alone happy and gay, but blest for ever, "I'd be a butterfly," and gladly pass through the ordeal of all the strange, painful, and distressful vicissitudes that may prepare and form my fortune, for not to flutter for a day and perish in a night shall we arise from our imprisoning cell:

"The grovelling worm shall find his wings, and soar as fast and free
As the transfigured One, with lightning form:"

no ephemeral moth born but to die, rather to know no end, and leave mortality behind.

Yet, apart from parables, which kindle our hopes and enthusiasms, an inexorable philosophy still asks the question, which, so far unanswered, we may fairly leave to wiser heads, as to the uses of the caterpillar race in the economy of nature.

Born to devour, and to be devoured, in large proportion, it may satisfy the curiosity of some, that caterpillars furnish a savoury food for robins, and that the use of the robin is to devour the caterpillar, which he does right manfully at the rate of three hundred for his breakfast: but it answers nought to the inquiries of those who seek a final cause in each atom of creation. The only end it seems to serve is what some call by the hard name of a "transposed end," an end cropping up in the path of its destiny and interrupting it—much in the way that a child gathers daisies, and fulfils their transposed end of his amusement by hanging them in a chain round his neck.

The caterpillar fulfils the transposed end of its existence, in the way of animal nutrition (though it never live to be a butterfly), albeit the good of man be never apparently reached, for he neither eats the caterpillar that devours the cabbage, nor does he even eat the robin that swallows the caterpillar that devours the cabbage; nay,

further, the "transposed end" of the caterpillar affects man in the shape of a blight; for when the caterpillar eats the leaf, the fruit is rendered worthless by the absorption of the juices that should have fed the leaves.

Then, What is the use?

Could the caterpillar speak as well as eat—and why

LARVA OF DICRANURA.

should it not? only it was sent into the world not to talk, but to do its duty—perhaps it might retort the query: Have you, my caustic friend, my utilitarian investigator, made the important discovery what you were sent into the world to do? and are you doing it? The use you'll find out by-and-by; and, meanwhile,

accept a suggestion very practically exemplified by our company of crawlers—as to a complete disentanglement from an old skin or a bad habit, for which an effort is required, that might have seemed in anticipation impossible.

It is thus described, and is too interesting not to record at length:

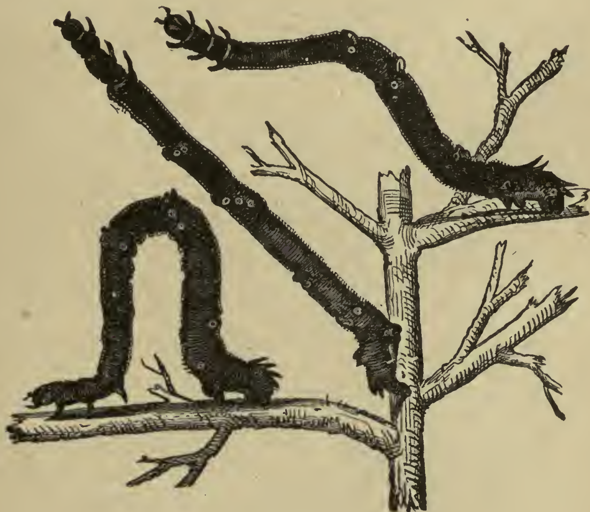
"There is a phenomenon in the life of caterpillars which we ought to point out, and which has attracted the attention of the most illustrious observers. All caterpillars change their skins many times during their life. It is not indeed enough to say that they change their skins. The skins or cases they cast are so complete that they might be taken for entire caterpillars. The hairs, the cases of the legs, the nails with which the legs are provided, the hard and solid parts which cover the head, the teeth—all these are found in the skin which the insect abandons.

"What an operation for the poor little animal!

"The work is so enormous, so troublesome, that one cannot form a just idea of it. One or two days before this grand crisis, they leave off eating, lose their usual activity, and become motionless and languid. Their colour fades, their skin dries by little and little, they bow their backs, swell out their segments.

"At last this dried-up skin splits below the back, on the second or third ring, and lets us have a glimpse of a small portion of the new skin, easily to be recognised by the freshness and brightness of its colours.

"When once the split has begun," says Reaumur, "it is easy for the insect to extend it; it continues to swell out that part of its body which is opposite the split. Very soon this part raises itself above the sides of the split; it does the work of a wedge, which elongates it:



THE LOOPER CATERPILLAR.

thus the split soon extends from the end or the commencement of the first ring, as far as the other side of the end of the fourth.

"The upper portion of the body which corresponds to these four rings is then laid bare, and the caterpillar has

an opening sufficiently large to serve it as an egress, through which it can entirely leave its old skin. It curves the fore part, and draws it backward; by this movement it disengages its head from under its old envelope, and brings it up to the beginning of the crack; immediately upon this, it raises it, and causes it to go out through this crack.

"The moment afterwards it stretches out its fore part, and lowers its head.

"There now remains for the caterpillar nothing but to draw its hinder part from the old case. This excessively laborious operation is finished in less than a minute.

"The new lining which the caterpillar has just put on is fresh and bright in colour. But the animal is exhausted by its fast, and the efforts it has made, and requires a few hours in which to regain its equilibrium."

Apparently the caterpillar is an adventurous being, much addicted to attempting and never failing to accomplish the most difficult feats of the acrobat.

Having, as we have just seen, succeeded in turning himself inside out; there are species which attain the yet more difficult art of suspending themselves head downwards or by the middle of their bodies before commencing the operation of forming the cocoon. The operation is attended with considerable difficulty, and is one of which a mathematician might be proud. It had escaped the observation of many naturalists, although the little creature which so successfully performs it is one of the most common of our English caterpillars the little

Vanessa urticæ, common on the stinging nettle, and distinguished by numerous black specks on its dusky body. The plant on which it feeds seems to afford too insecure a support for the intended chrysalis, and the insect, on the approach of its transformation, quits its usual resort and seeks some more convenient point of suspension, where in the following manner it commences operations.

Threads are laid, in most admired disorder, as a covering to the surface of the body from which it desires to hang. To this earliest layer a fresh labyrinth of silken threads is added, covering a smaller surface, and so on, ever contracting the extent whilst thickening the central mass, and thus forming a little mound of loosely-woven fibre, just firm enough to bear the weight about to be imposed upon it.

If we had contrived such a mechanical device, should we not have cast about rather for a hook or a thorn to hang from, and woven the loop on the body to be suspended? But the hook is there before, and has already answered many useful purposes, before this last, to the body of the caterpillar. The membranous feet of the little creature are armed with tiny hooks of various lengths, with the aid of which it suspends itself.

By wriggling contractions and elongations of its body it pushes the hindermost legs against the hillock of silk, so firmly as to entangle them in its meshes; it is then seen to "let go" and fall securely into a vertical position. It hangs there, but not idly, sometimes as long as

twenty-four hours, engaged in the sober, staid operation of "splitting its sides" with labour—not with laughter—and when split, in folding downwards like a cast-off garment the striped and dusky skin, bristling with ebony spines, in which it crawled so long.

THE COMMON CATERPILLAR.

No longer useful to its possessor, this garment must be not only folded into the smallest possible space, and gradually, by means of continuous contortions, pushed upwards till it covers only the narrowest end of the chrysalis, but must be discarded whilst the chrysalis remains *in statu quo*.

And how shall this be done?

Let Blondin live and learn. The creature has neither legs nor arms, and must yet set itself free from the skin and reach the threads from which it is suspended. Its supple body has a contractile power which supplies the office of the limbs. Between two of its segments the

CHRYSALIDES.

insect seizes a portion of the folded skin so firmly as to support the entire body. It now curves slightly the hinder parts, and draws the tail entirely out of the sheath in which it was enclosed, and for an instant reposes before freeing itself entirely from the encumbrance. Curving the part below its tail, so that it can seize

the thread to which it holds on, it gives its body a violent shock, which makes it spin round many times on its tail with great rapidity.

During these pirouettes the chrysalis is acting against the skin, and the hooks of its legs fray the threads and break them or disentangle themselves. If unsuccessful in this effort, it begins to twirl itself in the opposite direction, and rarely fails the second time.

It is from the golden hue of this chrysalis, which is sometimes brown with golden spots, and sometimes entirely golden, that the term chrysalis (from χρύσιος, golden) was suggested to the ancient naturalists. From this chrysalis emerges in due time—and that very short—the common, but most beautiful, tortoise-shell butterfly.

The yet more common and less richly-tinted *Pieris brassicæ* is in its transformations a still more accomplished acrobat. It forms, like its neighbour of the nettle, a labyrinth of silk to hang from, but seems to prefer a horizontal to a perpendicular position, and acts accordingly, after having hooked itself firmly by the nails of the hinder feet to the point of suspension.

This caterpillar possesses the power of turning back its head on to its back after having lengthened its body to a certain point, and, with its six legs in the air, of reaching to its fifth ring. It can also, by bending sideways, bring its head, with the thread-spinning apparatus which is below, opposite and near to one of the membranous legs.

The caterpillar begins operations by fixing on this point a single thread, the first of those that are intended to tie it up securely.

But how can it throw the thread over its head?

A COMMUNITY OF CATERPILLARS.

The problem is almost as difficult as a boy's first essay when he has mounted his knickerbockers, and must get his braces over his shoulders. It contrives to catch hold of the thread with its head, and, drawing it to

the other side, it forms a loose loop over its double body. Having seen that this loop is firmly attached on both sides, it wriggles its head a little further back, spins another thread from its tail, which it firmly attaches on the opposite side, and then, by a jerk, contrives to pass the thread over the crease between its head and neck. Again and again it repeats the same operation, until it has formed a loop strong enough to bear its weight, when it completes its somersault, and, in little more than a day, its transformation into the chrysalis is complete.

But many other caterpillars are not content with fastening their horny case to a branch or rock. Before performing the feats we have described, they spin their houses of silk, in which they may undress and sleep, withdrawn from the vulgar gaze.

Some work in communities (see page 15), and make one large cocoon like a great silken bag supply the dressing-room for a large family.

Others gum together a case of leaves; some take to masonry instead of carpentering or spinning, and gum together a shell of earth or mortar, kneaded with silk, and finely plastered within. If disturbed before they have completed their transformation, they will put out their head, and gather little grains of earth, which they entangle in silky threads until the gap is completely closed.

Others again, especially in Australia, roof their abodes with shingle, after the fashion of our New Zealand

colonists; little bits of bark being cut, and placed together with all the regularity of an experienced slater.

In fact, there is no human mechanical art which may not find its prototype in insect architecture. Lake dwellings, cave men, bark huts, wigwams, woven tents, diving bells, clay houses, existed long before man adapted the materials around him to the varied conditions in which he sought to make his home. In these varied dwellings, whether of the finest silk, or the roughest masonry, the once grovelling caterpillar rests, sometimes

only a few weeks, sometimes a year, till it emerges in due time to a new existence, in which, careless of food or clothing, it flits from flower to flower, its only care being now the reproduction of its species ; and having laid its eggs, a few showers or a windy day close the chapter of existence of the spangled butterfly.

THE SPIDER AND ITS WEBS.

THE SPIDER AND ITS WEBS.

Part I.

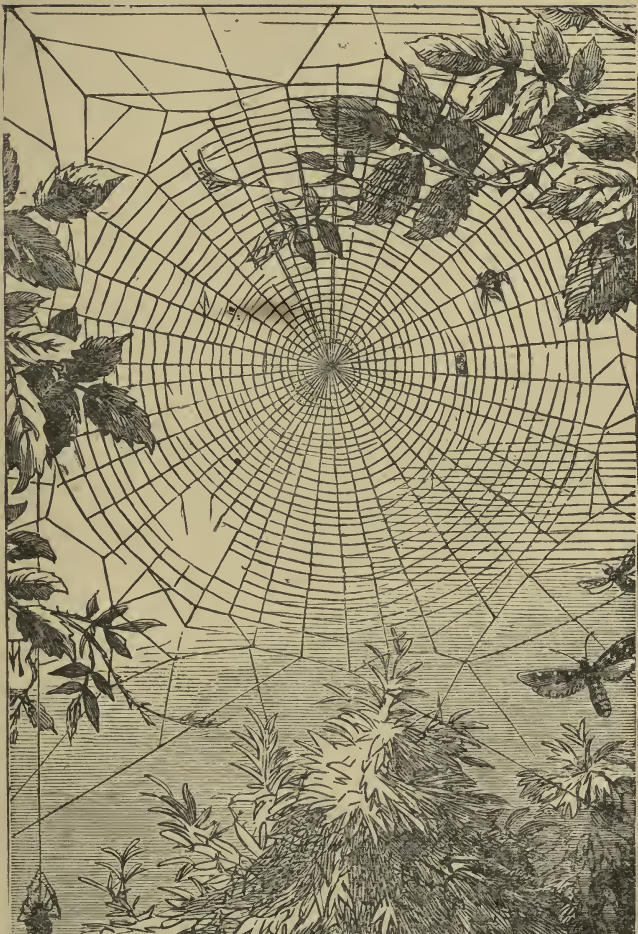
ONCE upon a time there was a spider. Not one of those happy creatures who spin their gossamer webs in green lanes or shady forests, where they glance in the sunshine or glisten with dew to make captives of the bright unwary creatures passing by in the free summer air; nor yet one of those unfortunate Penelopes who day by day weave afresh their webs, to be as often torn away by the unwearied housemaid, who with her turk's-head brush, poking into corners, peeping behind shutters and into the recesses of closets, would sweep to destruction the homes and hopes of the spider race. It was none of these, but a plain brown spider of homely birth and habits, suited to a cottage home, though possibly with hidden aspirations within him, such as may have swelled the breast of many a village Hampden who lived and died inglorious.

Well, now, to return to the spider.

His home was a hovel, the rafters of which at wide intervals supported the thatch, through which the smoke found scanty exit. Without splendour, there was spider comfort, and no rude winds tore his web to atoms, no officious housemaid with her ruthless broom brushed away his larder well stocked with flies. But the spider was restless. He dreamed of a lot cast in a higher region, where his webs might curtain the arches and festoon the pillars of a king's palace. Had he ever heard what Agur, the son of Jakeh, says of the spider, who "taketh hold with her hands and is in kings' palaces"? (Prov. xxx. 28) (though philosophers *do* say that the wise man had a lizard of some kind in his mind when he made that allusion).

"Alas!" said our cottage friend, "that my life should pass so uneventful and so unobserved on this retired rafter; that far from courting observation, or even attracting the notice of the sordid giants of the human race who inhabit this smoky den, I am never thought worth looking after, nor does my web, weighed down with dust and skeletons, demand of them the trouble of sweeping it away. A palace were a better sphere for me. My industry, my taste, and the fineness of my fabric might there win the admiration of all who had time to examine the ingenuity of its construction; while history might record my successful capture of a blue-bottle about to settle on the nose of the monarch!"

Happily, a good night's rest, after a plentiful supper,



THE COMMON SPIDER AND ITS WEB.

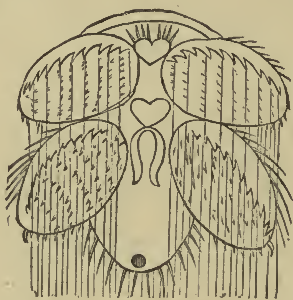
restored the spider to a more complacent state of mind with respect to his existing circumstances and his native home; and, balancing himself on the delicate meshes of his dusty web, he took measure of his present position, and of his actual powers, with a view to their exercise and improvement, in case the palace for which he longed should ever open its portals for his reception.

"Could I," he mused, "all untrained as I am in this lonely shed, weave like those lighter spiders whose slender bodies and lengthened limbs dart almost unseen through those lofty corridors, and weave in those elevated niches for which I so often sigh,—I, whose body has become heavy with the gross fare of this confined cottage,—my fate might be that foreshadowed by the poet, that 'vaulting ambition doth sometimes o'erleap itself, and fall on t'other side.' No. But I will fit myself. I will cultivate my powers, and extend my efforts, till my perseverance at least shall be worthy of imitation. Hitherto I have been content with spinning my web in this dark corner, where no effort is needed to stretch it from rafter to rafter. At least I will deserve, if I do not gain, the gratitude of the giants who sleep below me. How often have I watched them tormented in their sleep by some pertinacious fly, or some vicious little imp of a gnat, which settled on their eyelid, or buzzed in their ear, while they winked and winced, and turned from side to side to elude their plagues! But as they moved, their nimble tormentor darted out of reach, and came down again in an instant Ah! if I had

woven a nobler web, had I stretched it just over their heads, I might soon have trapped their plagues, and laid up a good breakfast for myself at the same time."

From this musing he proceeded to action, and from the inner recesses of his self-consciousness he evolved a long silken thread on which to hang not his argument, but himself.

Dropping first a little gum from his spinneret, he



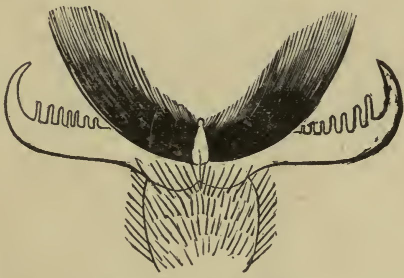
SPINNERETS, GREATLY MAGNIFIED.

proceeded gently to draw out from his body a long viscous thread. The end of it he carefully glued to his rafter, and then gently letting himself down, he rapidly but very carefully combed out this gum into a long thread between the claws of his hind legs, taking care that it was strong enough to support his weight; it instantly dried into hard fine silk.

Thus he was transformed into a species of pendulum,

the vibrations of which should affect, if not the history of the whole world, at least that of his own particular ambition.

Ignorant of the higher mathematics, or even of the simpler laws which govern gravitation, knowing nothing of the movements of the radii of circles, or of the arcs which they describe, he yet, in his vain attempts to reach the next rafter, and in the constant return of his little cargo of legs to the other side of his beat, described



SPIDER'S CLAW, MAGNIFIED.

an orbit regulated by mathematical rules as exact as those which were at the same moment carrying him, his web, his hovel, and the earth on which it stood, with unerring force through the regions of space. The point at which he aimed was a distant one, but to his ardent imagination it seemed not unattainable.

"What spider has done, spider may do," thought he, as he swung disconsolately back from his second unsuccessful attempt.

Again he applied his hind legs to the end of his abdomen, and gently teazed out a little more of the glutinous fluid, and carefully combed it into long silken hairs. "Perhaps," he reflected within himself, "with a little longer web I may succeed." Pausing a moment, he looked down and contrasted himself favourably with a human being who had lately entered the hovel, and had flung himself down on the pallet bed, with the hopeless and worn expression of one with whom effort and success had not gone hand in hand. The spider saw he was a stranger, and began to criticize somewhat contemptuously his soiled and tattered appearance.

But vanity had a large share in our spider's composition, and when he noted how the wanderer's eyes, which at first roved vacantly from object to object with a weary stare, at length rested on himself, he felt spurred on to more vigorous efforts. Never before had one of the familiar faces of that cottage been fixed on him or his work. "I will prove myself worthy," resolved he, "of human notice. That man shall learn now how even a cottage spider can float in air, where he cannot follow."

Again he tried; with a sudden motion, stretching out his legs, he pushed himself back, and swung once more towards the rafter. It seemed to retreat still further from his unequal efforts.

Again he tried. "England, Scotland, Spider-land expects every one to do his duty," was perhaps the thought that animated the renewed effort of the spirited

creature; and it seemed in some mysterious manner to communicate its energy to the lustreless eyes of the way-worn traveller. Warrior he seemed as well as huntsman, for his bugle and his sword hung side by side from his loosened belt. His eyes became riveted on the little animal, so unremitting, so dauntless, yet so unsuccessful. A fellow-feeling touched, perhaps, a sympathetic chord, and kindled the almost extinguished embers of hope that had well-nigh given way to despair, alternating with sad and revengeful thoughts.

Beneath that spider lay Robert Bruce, the defeated and almost hopeless hero of Scotland. Ah! little spider, had you taken hold with your hands of a king's palace, instead of the rafters of a cotter's hut, your lot might have been a more brilliant, probably a shorter, most certainly a less useful one.

Four times, five times, six times, swings the living pendulum from side to side, and failing to gain his own object, rebounds again, baffled, but not disheartened. The seventh time it gathers up its energies and repeats the effort. It has won at last.

"Never say die" thrills the giant heart of the champion of Scottish liberties, as he recalls how six times he has been defeated, and beholds the little animal safely resting on the rafter it has scaled at last with so much effort. Little did it think how a mighty courage had been rekindled by its tiny struggles, and that a page in history would ennoble the memory of the *cottage spider*.

But it is not every spider that can expect a place in story. Yet there is many another spider, which, if we watched it, would teach us a lesson, if not as grand as that which Robert Bruce learned, yet one very useful or interesting.

THE GARDEN SPIDER.

There are nearly 300 kinds of British spiders, living not only in cottages and halls, but in lanes and hedges, or trees, or in fields, but some burying themselves in the ground, and others, stranger still, living under water—not in it, like fishes or reptiles, but actually bottling the

air, taking it down with them, and keeping enough about them to breathe, and then, when that is exhausted, coming up again for a fresh supply.

But all these spiders weave webs, and the webs are almost as various as the spiders. If there are near 300 species of spiders in this country, there are as many different patterns of webs. Just as silk is woven into sarsenet, or satin, or velvet, or net, so the fairy gossamer of the spider's web is spun sometimes to form the brown dust-catching silk which festoons the neglected corners of a room; sometimes those beautiful patterns of network we see jewelled with dewdrops on a summer's morning in the hedges, or the fine threads which stretch from tree to tree, or the light hairs we catch up with our feet as we walk across a field in early spring. But all spiders spin, though all do not spin nets.

Some content themselves with spinning houses for their young ones, and very tight and tough houses those white and yellow silk bags are. Other subterranean spiders make silk hinges for the doors of their houses, of which we may have something more to say further on. And others make literal fishing-nets, for the water-spiders of which we spoke actually spin webs in the water and catch the water insects.

There is one spider, the tarantula, not an English animal (insect we must not call it, for spiders, small as they are, are not insects, but far more like crabs or lobsters), about which strange stories are told, not quite so pleasing as that of Robert Bruce's spider, for it is said

to have a poisonous bite, which forces people, not to try again like Bruce, but to dance like maniacs. The bite is not, however, very serious, and I have often caught the tarantula in warm countries without being hurt by it.

But there is another kind of spider, which by candle-light looks as large as a mouse running across a room, which is a very old friend of mine.

I once had one of these spiders, a sort of *Mygale*, as it would be called in books of natural history, which I kept tame in my bed for a year and a half, and which I think was quite as noble a spider as Robert Bruce's friend. It was in the island of Bermuda, which swarms with every kind of disagreeable insects, and where the mosquitoes, gigantic blood-thirsty gnats, not only murder sleep by their sharp shrieking buzz in the ear all night long, but thrust their long lancets through the skin and suck out the blood, raising great sores which are often very troublesome. No one can sleep there in peace without a mosquito net, or large bag made of bobbin net, which is hung from a hook in the ceiling, and covers the whole bed to the ground, like a huge gauze nightcap. But the mosquitoes are very active, and when you lift up the net to get into bed some of them are sure to be nimble enough to get in with you to keep you company.

Now my bedfellows were very troublesome, and would neither sleep themselves nor let me sleep. Sometimes they tasted the tip of my nose, then they bored my ears, then they ran their lancets into my eyelids, singing all the time most hideously

At last I determined to make friends with a large spider. I caught him one evening as he was jumping after the flies in the window curtains, and put him into a little bag which I fastened inside my net at the very top.

Then I fed him with large flies for a few days, until he began to find himself in very comfortable quarters, and thought of spinning a nest and making his home. I then cut a hole in the bag, and my spider soon spun a beautiful nest as large as a wine glass for himself, winding himself round and round, as he combed out the silk from the end of his tail. In this nest he sat perfectly motionless, for these spiders do not weave nets, but only homes for themselves and their young ones, and catch their prey by leaping upon them with amazing speed.

There at the top of the nest sat my friend, and often have I watched him when a fly or mosquito got inside our gauzy tent. I could fancy I saw his eyes twinkle as his victims buzzed about, till, when they were within a yard or so of the top, one spring, and the fly was in his forceps or nippers, and another leap took him back to his den, where he soon finished the savoury mouthful. Sometimes he would bound from side to side of the bed, and seize a mosquito at every spring, resting only a moment on the net to swallow it.

In another corner of the room was the nest of a female *Mygale* of the same species. She was not content with so small a house as her husband, but added some beautiful little silk bags or cocoons larger than a thimble, of very tough yellow silk made by herself, in each of which she

laid more than a dozen spider's eggs, which used to sit on her back when hatched, but which all disappeared as soon as they were old enough to hunt and leap for themselves.

I kept my useful friend in bed for nearly a year and a half, when unfortunately one day a new housemaid spied his pretty brown house, pul'ed it down, and crushed under her black feet my poor companion.

THE SPIDER AND ITS WEBS.

Part II.

THERE was another kind of spider in Bermuda, much more handsome than my bedfellow, but not nearly so great a favourite of mine, about an inch long, without measuring its long legs, and with a bright yellow and black body painted in beautiful patterns. This spider did not weave nets, but nooses of bright yellow silk. It spun them in the woods from tree to tree, sitting at the extremity of a branch, and then, taking advantage of a breath of wind, it would sail out into the air, carrying its thread behind it, till it reached the next tree, where it fastened it, and then started back again with another thread.

These spiders generally choose the trees on each side of a pathway for their operations, and the silken threads hang across it in myriads. When the large beautiful butterflies come fluttering down the avenue in the sunlight, they

often get their wings entangled in these cords. If the cord breaks at once, the butterfly escapes, but if not, in its struggles it would soon touch two or three more lines, and as soon as it was completely entangled the spider would come running along its thread from the tree, and rapidly moving round and round its lovely prey, would spin its gummy silk till the butterfly was completely fettered, when it devoured its captive on the spot.

I once saw two of these spiders together capture a bird, a greenlet, about the size of a wren, in this way. The threads had got so entangled round its wings, that the spiders were able to seize it as it struggled in the snare, and had bitten its throat so severely that, though I freed it after watching the battle for a minute or two, the poor little bird died in my hand.

An ingenious American tried to make use of this silk, and once exhibited at a show in Bermuda a yellow silk handkerchief of spiders' webs. But though it was far finer than silkworms' silk, it was so troublesome to collect that no one attempted the manufacture afterwards.

There is another spider which I have often watched in Greece and the Holy Land, which is, I think, the most wonderful of all in its architecture. It is also a *Mygale*, but much smaller than those of which we have been speaking, and is commonly known as the Mason Spider.

This spider is entirely nocturnal in its habits, and never either hunts or feeds in daylight, but makes itself

SPIDER ATTACKING NEST OF HUMMING BIRDS.

a most comfortable house, where it is perfectly safe and locked up till sunset.

It bores a circular hole in the side of a bank, or any sloping ground, about the size of a man's middle finger. The tunnel is most exactly rounded, and from 2 to 4 in. deep. To rake up the earth and shovel it away, it has a row of hard points on its head, like the teeth of a rake. As soon as it has scooped out the soil, it lines the tunnel with silk, through which no damp can penetrate; and no drawing-room was ever so beautifully plastered, and papered with damask, as the mason spider's sitting-room.

But the door is the most wonderful part of this mansion. The spider does not like draughts, and cannot bear having the door left open, so it contrives that it shall shut itself. The door is perfectly round and flat, about the size of a sixpence, but very thick, made of thin layers of fine earth moistened and worked together with fine silk, so that it is very tough and elastic, and cannot crumble; with a wonderful silk hinge at the top. The hinge is elastic silk, very springy, and so tight that when the door is opened it closes immediately with a sharp snap.

But the door does not fit on to the house, but into it. It has a beautifully hard socket, bound with silk, into which it fits very tightly, while the outside is covered with bits of moss or other things glued on, so that no one can possibly detect it. The only way of opening it from without is by a pin, but even then I have often seen

the spider keeping tight hold of the bottom of the door with her claws, while holding on to the walls of her cell with her whole force.

Here the little architect remains all day, and at night spins a few threads among the grass near her home, in which she catches her prey; but she also hunts for food by leaping upon beetles, and carrying them into her tunnel.

So attached is she to her cellar, that I have often cut the nests out of the earth and brought them away in my pocket with the inhabitant within; and I have now before me a row of these nests, all with their doors fitting exactly alike. I once cut off the door of a nest near my tent, and next day found that a new one had already been hung on its hinges.

One more spider I should like to say a word upon, because it is one we may often see in this country, and is very little known. It is the water spider. It has a very long Latin name, *Argyroneta aquatica*—*i.e.* the water silver spider, and it is very interesting, because, as we said some time ago, it bottles up air and takes it under water to breathe with. In fact, had people only watched water spiders as Robert Bruce watched the cottage spider, diving-bells would have been discovered hundreds of years ago, and people might have learnt how to go to the bottom of the sea and save the treasures of wrecks.

We know there are two ways in which divers descend and work under water. One is by the diving-bell, which is like a great bell dropped into the water, so that the

air cannot escape; the other is by a diving dress, in

THE MASON SPIDER AND ITS NEST.

which there is a supply of air inside the clothes of the diver. The spider uses both these methods.

It lives in ditches and stagnant pools, near the bottom, and weaves a strong silken cup of the shape of a bell, which it fastens by long cords stretched on all sides to the stems of water-weeds, and which is filled with air. As the bag is always kept mouth downwards by the cords, the air cannot escape; and here the spider lives and deposits its eggs in little capsules or bags, where its submarine cradle keeps them perfectly safe. Its body is covered with long hairs, and these hairs hold the atmosphere all round it, so that when it swims lying on its back—which is its regular method of moving about—it looks like a silvery bubble of air. It often comes to the surface to replenish its supply.

The walls of its nest are very thin, composed of a tissue of fine white silk, to which is attached quite a fringe of threads to anchor it to the weeds. Here the spider lives, with his head downwards, ready to pounce upon any unwary insect. In winter, when it sleeps for many weeks together, it weaves a flooring to its nest to secure it from any accidental entrance of water.

I could tell of many other wondrous kinds of spiders' webs, but my readers will see from the few here mentioned how full of marvels is even the little spider's world, and how much there is to instruct any one who would rather go through life with eyes than with no eyes. The spider will teach us not only the lesson of perseverance which Robert Bruce learnt when he was nearly giving way to despair—it will teach us how to spin and how to weave, how to hunt and how to snare.

It gives lessons in gymnastics, in swimming and in leaping, and it has solved many a problem in mathematics before Euclid was born. Look at the spider's web, and see whether "any hand of man, with all the fine appliances of art, and twenty years' apprenticeship to boot, could weave us such another."

It is remarkable that spiders' web, though amongst the finest, is also one of the strongest substances.

A bar of steel an inch thick will bear a weight of nearly sixty tons; but it is said—on good authority, too —that a rope of spiders' silk an inch thick, would bear up a weight of seventy-four tons; that is to say, it is a quarter as strong again as the bar of steel. Whether this is positively true is not certain; but there can be no doubt whatever that a thread of the silk $\frac{1}{4000}$th part of an inch thick will bear up fifty-four grains, so that there is no reason why the rope should not bear up the seventy-four tons.

These webs are so tough and strong; why don't they make some use of them?

Well, one reason is that spiders are very difficult hands to manage; they have a disagreeable habit of biting and killing one another; and when compared to the dull, quiet, patient silkworm, are not pleasant things to handle or have to do with. But the attempt has been made, and not only have large numbers of spiders been brought together into a nursery, and there led to lay eggs; but the young have been brought up, made to spin, and the silk has been wound off and woven.

The female spider is the spinner, and the utmost that can be got from a single insect is about 150 yards, weighing $\frac{1}{20}$th of a grain, while a large silkworm's cocoon will yield 300 yards, weighing 3 grains.

The silk is of two colours, silver-grey and golden, and both may be drawn from the same spider, at different points of her spinning organ, and of two different kinds also.

The yellow is the strongest and most elastic, and after being stretched flies back again to its old length, like a thread of india-rubber; while the silver crinkles up, and is apt to snap if stretched too hard. But both kinds are wanted in building a web; and if you look at one carefully, you will see with what skill and beauty every part is arranged—one kind of silk for the strong straight outer edges, and the other for the swaying, bending cross-beams.

Although a silkworm spins but one cocoon, and is then done for, a spider, after yielding 150 yards, has only to rest for a few days, and is then quite ready to have 150 yards more drawn off; and so on, a dozen or fifteen times in a month.

Dr. Wilder, a very wise man, who has been studying spiders for years past, and knows more about them than a dozen dictionaries, says that all his apparatus for winding off their silk consisted of "two large corks, a bent hair-pin, two large common pins, a bit of card, and a bit of lead." All I can tell you now is, that the doctor catches the spider between his finger and thumb, so that

two legs are turned back out of the way, applies his machine in the right fashion, and winds away as easily and smoothly as if from a lifeless cocoon.

The thread of a single spider is so fine that it cannot be wound off *alone from the reel*, and so the cunning doctor arranges a large number of spiders, and contrives to wind off all their silks together in one thread.

The great difficulty is, as I told you, to prevent the blood-thirsty spinners from killing and devouring each other. Only a few out of every hundred young spiders, brought up together in one web, ever escape alive to marry and set up housekeeping and separate establishments for themselves; and a hungry wife has been known, first to kiss her husband, and then seize on him and eat him up, which, as she is 100 times as big as her lord and master, she can easily manage.

An ounce, says Dr. Wilder, is 437½ grains, and as each spider yields one grain, it will take about 450 to produce a yard of silk, or 5,400 for a dress of twelve yards. Each silkworm yields about two and a quarter times as much as a spider of one season; so that we should want 200 worms for a yard of silk, and 2,400 for a dress.

This would make spiders' silk just two and a quarter times as dear as silkworms'; and so, for the present, Mary, there is not much chance of our having dresses of spiders' spinning.

BEES AND BEEHIVES.

BEES AND BEEHIVES.

PART I.

"Where the bee sucks, there suck I."
"The bee is small among the fowles, yet doth its fruit pass in sweetness."

"THOSE who live in glass houses must not throw stones;" but as there is no rule without exception, we throw it out as a suggestive inquiry to any of our captious young friends, whether the little winged dwellers in glass hives, exemplary in all the relations of life, and faultless in their social and moral qualities, may not be privileged to have a fling in any direction?

"Not at me, if you please," tartly replies our wiry friend, whose indefatigable industry bears testimony to the fact that he learned to some purpose when a child the infantine ditty, "How doth the little busy bee," &c. "Not at me, if you please; I mind my own business. I am up early and late; never trouble myself with other

people's concerns, and no one can accuse me of idleness; and the hoards I have laid up against hard times are plain proof that I gather honey all the day, and sometimes half the night too."

None of the sweetest, we fear, if it smacks of the tone and temper wherewith it is proclaimed. It may sometimes be found to be but lost labour that we haste to rise up early, so late take rest, if our worldly store lack the mellow sweetness of an abundance culled from earthly flowers, under the sunshine of a heavenly blessing, among the unselfish fellowships and countless charities of life, which are as the pleasant hum of bees in the sultry air of a summer's day of toil. But not being ourselves the denizens of a glass house, we will leave that stone for our winged friends to fling.

"Not at me, surely not at me," cries a second, with careless confidence. "I was never out of temper in my life; I take things easy. 'Live and let live,' 'Care killed the cat;' and if I cannot get things to my mind, I never fret; I e'en let them pass. 'It will be all the same a hundred years hence,' if things *are* all at sixes and sevens now."

Ah, good friend, free and easy, bathe as you may in the waters of self-approval, I think we shall yet find a vulnerable point, even in that happy-go-lucky style of yours. What work will you ever accomplish, what edifice rear, that will not bear the marks of such careless ease?

In the hive of glass it is all sixes and no sevens. Very particular gentlemen are these builders of a suitable

"WHERE THE BEE SUCKS."

residence and storehouse for their colony and their queen. Destitute of any apparent guide of measurement, what need have they of inch rule, of compass, or artificial hexagon? The eye, the mind—whatever that may be in the insect world—the hand, all work in faultless union, and produce a result as marvellous in its exact proportions as in its adaptability to the several needs of the architect; and if, in the material fabric of their city walls, there be a strength and adhesiveness inseparable from a degree of bitterness to the taste, the sweetness and abundance of the store within those walls invite us to leave to its winged workers the task of flinging this stone at the slovenly and the careless.

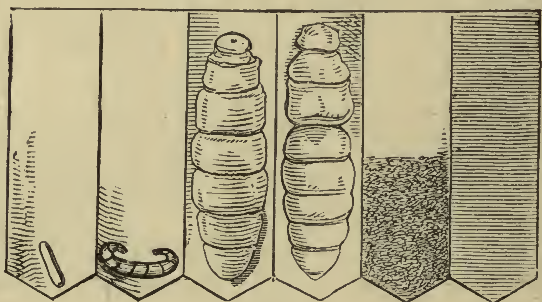
"Not at me," sternly ejaculates a third. "I am particularity itself. I see to it with my own eyes, and if the work done by my orders is the thousandth part of an inch awry, I have it all undone; those that work for me must make straight work of it, and look sharp, or I come down upon them short and sharp."

Sharper truly than that sting for which the colonists of the hive find no such use. No task-master is theirs, no idle hands, no careless workers, each works for all, and all enjoy the fruit of the labour of each. Excepting the royal lady, who, engrossed by cares maternal, sits apart in the spacious chamber constructed for her by her loving subjects, all work in harmony. Each one knows his task, and though man knows not to what tribunal of conscience their fidelity may be referred, or by what meed of self-approbation rewarded, we have yet to hear of one among

the bees who will bind heavy burdens on others which he refuses to touch himself.

So, in some interval of leisure from their more immediate duties, some speculator among them on human systems may fling this stone also.

"Not at me," exclaims number four. "I work as hard as any. Example as well as precept is my motto, and I carry it out, and never tell anybody to do that to which I am unwilling to put my own hand. Gladly



CELLS.

1. Ovum. 2. Larva. 3 and 4. Chrysalides. 5. Pollen. 6. Honey.

should I take a little relaxation, or breathe a breath of fresh air now and then, if I felt it consistent with my duties to others to enjoy for myself what I deny to them."

Then go to the bees, thou slave to the desk and the wheel. Where would be the sweetness of their honey, the strength of their wax, the buoyancy of wing, and that cheerful hum—where the elasticity and health of their

busy insect life—were not fresh air and sunshine a part of their daily life, a material element in their existence?

Nay, more, the first hours of their daily round of activity are spent outside the hive; and with the nectar of the flowers they imbibe the breath of early morn and the first freshness of reviving nature. The day-spring is to them truly the spring of the day's activities. Their first flight is upwards, their earliest effort, heavenward.

Those pupils of nature's instincts return to their indoor life about the hour when worn and exhausted men and women creep forth from their imprisoned life, to breathe the noxious dews of evening, the staleness of an atmosphere from which the vital energy of sun and oxygen have been withdrawn, and return to add the fatigue and oppression of night to that of the day before resuming the diurnal toil in the narrow hexagonal cell of their daily labour.

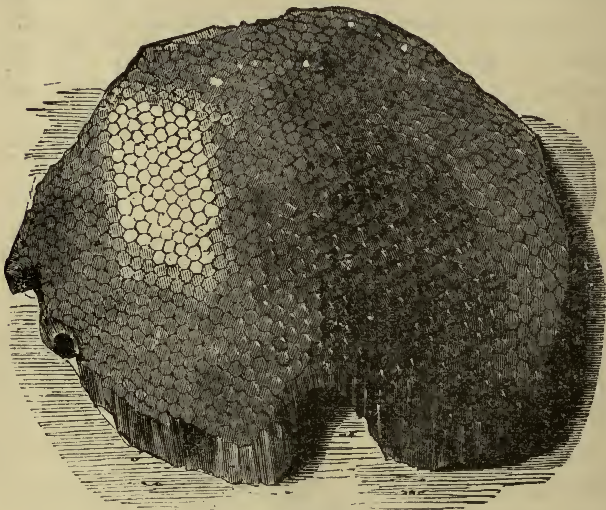
Yes, fling that stone from your airy height, ye happy living things, that mount on the morning breeze and scent the early odours of the dewy flowers. Ye may find a vulnerable point in many a son and daughter of leisure as well as in the person of the mechanic, the student, or the man of business.

"Not at me, not at me, for I hate artificial life and all that belongs to it," gladly exclaims the child of the country. "Give me the simple humming bee in its home in the wild woods, where it makes honey for its own wants alone, enough for its family requirements, and never invites the covetous propensities of rapacious

man to stifle their young lives and rob their winter store."

Ah, there you remind us of the best that can yet be said of these faultless creatures.

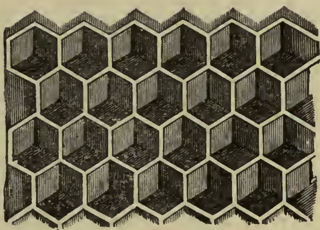
No useless hermit colony, with self and selves for the end and object of their labours; they never stop short



HONEYCOMB.

when they have built their comb and gathered honey for themselves alone. As the summer is prolonged, and their sphere is enlarged, so are their efforts expanded, that other beings, often their most cruel enemies, may share the sweet results of their toil.

Unspoilt by artificial life, and, so far as we can see, utterly unchanged in their simple habits and lives of active usefulness by all the refinements of cultivation, the bees inhabiting the most delicate of glass hives in the loveliest of gardens are as busy as the bees before the flood, as united in their action, and as ready to quit the homes of luxury at the call of their leader, as if they were the first bees on whom the necessities of exertion, of union, and of forethought had devolved. Humbly and contentedly they betake themselves to the rudest shelter, and



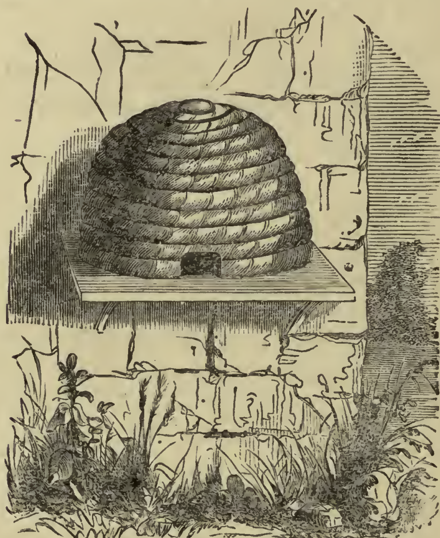
SECTION SHOWING CELLS OF HONEYCOMB.

seek in the wildest retreats of nature as in the richest garden the nectar concealed alike under the simplest petals and the fragrant cluster.

Too active, too happy, and too kindly to fling a stone metaphorically, or to use literally their sting whilst unprovoked, their pleasant humming falls on our ear as one of those soothing sounds in nature, like the plashing of the waterfall, the sough of the wind among the trees, or the music of the

"hidden brook
In the leafy month of June,
That to the sleeping woods all night
Singeth a quiet tune;"

which harmonize with good and sacred thoughts, and suggest alike to the contemplative and the active mind



THE SWISS HIVE.

the combination of their respective gifts in a useful yet not thoughtless existence.

But the bee was not born to hum only, it only hums to beguile its work.

Let us watch the little tribes as they pass to and fro

from their hive this morning. Fear not their stings, if we stand aside, and do not put ourselves in the way of the busy citizens. If some human monster will obstruct their passage, and come between them and their storehouse gate, and does not move on at the sound of an angry buzz, the way *must* be cleared, even at the expense of an occasional sting. So let us keep to the side, and they will be far too busy to turn from their labours to examine, still less to molest us.

First of all, we see some half-dozen loitering idly about the door.

No, not idly, for see how they scrutinize each fresh arrival, as if to say, "Have you brought home a proper load of honey, or have you only been at play?"

But this is not their chief duty.

They may be only making a passing salute, inquiring of their returning friends the state of the weather, or the flower crop, whether the white clover is plentiful, or the lime-trees are exuding honey well. They are there to warn off intruders.

If we approach too near in front, one of these sentries will dash forward with an angry buzz; and if we do not wisely take the hint, the brave little soldier will soon return with a reinforcement from the guard-room to enforce the command. Horses, dogs, and other animals understand this threatening buzz very well, and soon retire. But their smaller foes are not so easily repelled.

The sentinels touch with their antennæ every creature that tries to creep in, exactly like a soldier on guard

demanding the pass-word. Now hornets, wasps, and moths, who, like human beings, do not make honey, have a very sweet tooth, and know where the nectar is stored. They often try to pass the barrier, and, being individually stronger than a bee, would succeed, were not the sentinel speedily reinforced. We may often see dead wasps laid in front of the hive, and sometimes can

STING AND POISON-BAG OF WORKER-BEE.

witness a pitched battle, though the intruder is generally driven off, and seeks safety in flight, like a robber with a bad conscience.

When the guard is relieved at night, the door is often barricaded with a wall of *propolis* and wax, to keep out the night-flying moths.

But the bees who are passing and repassing the sentries are not all laden alike. Some of them have little yellow or red tufts on their legs, others have none. But all who return are laden.

There are three substances required in the hive—pollen, or bee-bread, the food of the youngest larvæ; wax to make the combs; and honey for the support of the community. Those with tufts on their legs have

THE WORKER AT WORK.

been collecting the pollen from the stamina of flowers, which they carry worked into lumps, and retained by the hairs on their hind-legs. The purveyors of honey and wax carry their stores, drawn from the nectar of flowers and the sweet juices of trees, in their throats.

To understand how the pollen is carried, we should examine the hind-leg with a microscope. We shall then see that the upper joint is flattened, and its edges sur-

rounded with stiff hairs, which form a sort of basket, into which the powder is put by the action of a sort of brush of short hairs which cover the lower joint.

When the bee enters a flower, it takes a plunge among the pollen covering its whole body, and then brushes itself down into the basket on its thigh, till a good-sized

TONGUE OF WORKER-BEE.

ball is formed. If it cannot complete its load in one flower, it will always seek out another of the same kind; but never on any account will it mix the pollen of two different kinds of flowers, unless by accident. Thus we always see the ball of a uniform colour, red, yellow, and white pollen being never mixed.

When the pollen-bearer has entered the hive, it pushes its burden into a cell, and another bee follows, and kneads up the mass with its jaws, packing it tightly down.

The honey-gatherers and the wax-gatherers—for these are really the same—draw in the juices from the flowers by their trunk, which serves as a mouth and a pump, through which the liquid passes into the first stomach, and thus is carried to the hive. But often the labourer does not wait to disgorge itself into the cell, but, on arriving at the door, opens its throat, when another bee, perhaps one more aged and feeble, and less capable of field work, though perfectly fit for domestic toil at home, receives the sweet load and discharges it into the storehouse.

Of course the workers feed themselves while they are out, and often give a supply to their friends by the way. They also feed those employed on the combs by going to the place where they are working and stretching out their trunks. The other bee inserts the end of its trunk, and sucks up the offered honey without having to leave its work.

But how is the wax supplied?

This was long a problem, till it was discovered that wax was a secretion, or rather an exudation formed in very thin layers between the plates of the abdomen of bees. That it is in some way made from honey Huber ascertained, because bees fed only on pollen did not secrete it, and those fed on honey or syrup did so.

BEES AND BEEHIVES.

PART II.

LET us now follow the workers inside the hive. And here, if we have not got a glass hive through which to watch, we must be content with a peep by the eyes of others.

Just beyond the sentries are stationed those who relieve the purveyors from the field. Others are busy in cleaning and sweeping out the bottom of the hive, others in storing honey or bee-bread, more still in forming new combs, and many others in tending and feeding the young larvæ in the breeding-cells, or waiting on the queen. For all these working bees, industrious though they be as labourers, assiduous as nurses, are toiling not for their own—for they never are either fathers or mothers—but for their brothers and sisters.

As with the wasps, so among bees, there are three sexes—the drones, or males, who are only hatched in

summer, and neither work nor sting; the queen, of whom there is only one at a time in each commonwealth; and the mass of the community, or workers, who are in reality females stunted in their growth, and differently fed and housed in their infancy. So far they resemble other hymenopterous insects, as the ants and wasps, of whom we shall talk elsewhere;* but in the origin and government of the little commonwealth, which

DRONE, QUEEN, AND WORKER.

each hive in reality is, they differ much from their nearest cousins the wasps.

The female, or queen bee, is far less active than the queen wasp. Very few people not bee students have ever seen a queen bee.

Unlike the lady of the yellow bands, she takes no share in the founding of a new colony. She never works from the day of her birth to her death. She is worshipped like an Eastern potentate, in the strictest

* See pages 85 and 177.

seclusion, indulged and petted, instead of going forth with the first warm rays of a spring morning, like some hardy Norseman of old, to found new colonies, and lay the foundations of a busy city.

Nor is she to be blamed for this. Her form and nature forbid the effort. Though her body is twice the size of that of a working bee, her wings, unlike those of a wasp, are very short, and can only bear her up for a little time with great effort, while her abdomen is far too heavy to enable her to move about with ease.

But how, then, is a new colony to be founded?

Here comes in a wise provision of Nature's God to meet the case of the bees. They build no houses for themselves. The time which the wasp must devote to the preparing, fortifying, and enlarging of the walls of its house, the bee, relieved of this labour, expends on the collection and preparation of food for the winter. The one perishes with the early frost; the others, huddled together, and securing warmth by their crowded numbers, are ready to recommence their labours with the opening of the first crocus of spring.

In a state of nature the bees find hives in clefts of the rocks, in hollow trees, and sometimes in holes in a dry sandy bank. There they find dwellings ready made to hand, and quite as convenient as the most comfortable straw hive or the most neatly-finished wooden box which their owners provide for them in servitude, though not in captivity. We see how bee-nature remains the same

through all generations, how the new swarm will get into a chimney, a hole in a wall, the eaves of a house, or under the thatch, the hereditary instinct having never been lost, through thousands of generations of hive-homes.

Still the bee has no strong prejudices, and when the bee-keeper has provided a comfortable hive, and smeared

STRAW AND GLASS HIVE.

it well with sweet syrup, the queen, if once she has dropped into her quarters and found them warm and sweet, is not disposed to assert her right to choose her own residence, but settles down at once, the monarch of all she surveys within.

In many respects the hives which man provides suit

the bee taste better than most of the homes they could find for themselves. In the first place the bee likes neatness and symmetry, and the combs can be formed more evenly and regularly than in a shapeless hole. Then the holes in the rocks have often large openings, which it is very difficult to build up sufficiently to prevent the intrusion of many unwelcome visitors.

WOODEN HIVE.

Experience, too, has taught men in different countries to provide hives suited to the climate.

The English straw hive is made for warmth, and is well thatched with an extra covering in winter, to prevent the frost benumbing the little prisoners. I do not think the bees like the wooden hives so well as the old-

fashioned straw ones, unless they are double-cased, and very well sheltered, for they are much colder. But they have no objection to a wooden box to work in in summer, with a thatched house above it, to which the whole family retire when the summer season is over.

In North Africa, where warmth is not required, and where the bees are in fact wild, and allowed to roam and choose for themselves, the Arabs hang up in the trees rolls of cork bark with a cork lid, and quite open at the bottom.

The bees have the instinct readily to choose these, because they are safe from prowling intruders, who, unless they are winged, cannot get into the hive, which is suspended from a bough; while if any winged thief attempt to fly in at the bottom, there is an army of defenders ready to dash down upon him, and give him a lesson in honesty. Thus I have seen an incautious bird, which has earned its name of bee-eater from its partiality for devouring bees and wasps, skimming like a swallow and snapping up the workers as they returned heavy-laden with sweets, till at length, hovering too closely under the hive, a myriad of indignant soldiers dashed out together, and whether they stung him or not I cannot say, but he soon sheered off thoroughly humiliated, and came back no more.

These cork hives are also cool, so that the combs do not melt under the shade of the tree in summer, though they keep out the winter rains.

In Palestine, where the climate is still hotter, the bee-keepers have devised a yet cooler fashion of hive. They make a large pipe or cylinder of clay, about two feet in diameter, and more than a yard long, open at the ends. They smear it inside with honey, and when they have shaken the swarm into it, they lay it flat on the ground, and plaster up each end with clay, leaving only small front and back doors, into which no mouse can creep.

They generally heap about twenty-one of these hives in the shape of a pyramid (for they keep vast numbers of bees) in a tier of six at the bottom, diminishing by one each row. The whole are then plastered over with earth and clay, and as they stand in the yard look very like a hen-house. At both ends are stuck up a number of boughs, the more prickly the better, for the double purpose of assisting the laden bees to alight, and of protecting the entrance and the neighbourhood from "bee-eaters," winged or creeping; for lizards as well as birds are among their enemies there.

When summer is nearly over, the Syrian bee-master begins to help himself. This he does on the principle of "live and let live." With face and hands well muffled, he removes the clay from one end of the tube, and with an iron hook pulls out the combs one by one, handling them carefully, as the hook detaches them from the top of the hive. If there are any young or bee-bread, he carefully cuts off that portion of the comb and replaces it in an upright position. He takes care to leave enough

honey for the winter store, only removing the combs at one end. The next year he opens the other end, so that the bees are compelled to renew them every two years, and they never become clogged, as in our old hives, with the cast-off skins of larvæ till they are too small for use.

These bees must have the bump of locality largely developed, for though I have seen a pyramid of seventy-eight hives, I never noticed the busy bees at a loss to find their own. Lighting on the bushes every minute in swarms, each, after a minute's pause, went direct to its own home, though there was as little to distinguish one from another as in the rows of houses in some new suburban street.

In tropical countries, again, as in India, there are bees which dispense with hives altogether, and which hang their combs openly under projecting ledges of rock, generally in the deep ravines of rivers, where they are secure from all enemies except winged ones, and these we must suppose they manage to keep off by a large standing army, for the soldiers must be increased in proportion as the position is exposed.

But how is the colony formed? How is a new kingdom established?

Here the natural increase of the population acts along with the instinct of the queen No queen can endure a rival near her throne, but the working bees, careful to provide against accidents, and maintaining that "the king never dies," take care each spring to rear a few

female eggs in cells on the edges of the comb, very solid and much larger than the others, and to feed the larvæ in these cells with food different from that supplied to the workers, being heavier and sweeter. This alone, along with the greater space of the cell, is enough to form a queen instead of a worker.

When the queen larvæ are nearly ready to leave their cells, they make a peculiar noise, which very much disturbs the peace of mind of the reigning queen. She rushes over the combs in a fury, endeavouring to tear the young queens out of their cells; but each is guarded by a body of workers, who, at other times so respectful to their monarch, now venture firmly to resist her.

This is more than any lady, accustomed always to have her own way, can endure. She rushes about distracted, and even frenzied; drops eggs anywhere, regardless of the use of waxen cells; and runs over the bodies of the workers, as they cluster on the combs. None so mean to do her reverence—none draw aside and stand respectfully in file on either side as she passes, after their ordinary habit—she has lost her guard of honour, and is indeed a deposed sovereign in her own palace.

But though her subjects seem for the moment to be rebellious, it is rather a panic than a conspiracy which has seized the community. They so far forget themselves as to strike their royal lady—she so far descends from her dignity as to run a Malay muck, striking every one she meets. This only aggravates the tumult. Every

worker, as it returns laden from the field, is seized with the excitement, and runs about with pollen on its legs or honey in its stomach, never thinking of depositing its burden, but, smitten by the epidemic of confusion, joins the general scramble.

SWARM OF BEES.

At length the queen finds her way to the door, and rushes forth to cool her fury in the open air. It is only the second time in her life that she has ever left her palace. But now it is for ever. But she is not alone. She finds thousands of her subjects still devoted to her, chiefly the elder and more experienced, who

prefer to follow the fortunes of their self-expatriated sovereign rather than run the risks of republican anarchy in their native hive.

One breath of fresh air seems enough to calm their ruffled spirits. The queen cannot fly far, and, following the guidance and example of some of her devoted attendants, she settles on a branch or in a cavity of a tree, rock, or building. The swarm collects around her. That extraordinary cluster is formed of one row of insects hanging on, with another and another suspended by their fore-legs hooked in the extremities of the hinder legs of those above them, till the first rows have to bear a weight a hundred times that of their own body.

When the cluster has been shaken into the hive provided by their owner, if only the queen have been enclosed with the others, without the delay of an hour they betake themselves to form combs and to arrange the furniture of their colony, evidently feeling that, so long as they have their queen with them, they are no exiles. They can quit their country, but not their allegiance. If, however, they find that too many have left their old home, and that the swarm is needlessly large, a portion will return in two or three hours.

BEES AND BEEHIVES.

Part III.

BUT now, supposing we have them safely encased in their empty hive, how are they to go to work?

The old queen has many eggs to lay, and these must not be wasted. There is no time to lose, and combs must at once be found. Here comes into play the most marvellous part of the bees' constructive instinct. The workers who have fed themselves on honey attach themselves in a row by their fore-legs to the hive, and hang motionless, while others hook themselves on to their hind-legs by their own fore-legs, and others again hang on to them, till a long chain is formed, and looped up by the different chains joining at the bottom. Thus they all patiently wait, till they have secreted plates of wax between the scales of their abdomen.

As soon as a bee finds it has a plate of wax ready, it leaves its place in the ranks, takes the wax between its

mandibles, kneads it, and fixes it to the top of the hive. This done, it at once goes off to the fields for a fresh supply of honey. Others follow with their wax; and when there is a sufficient quantity deposited to work with, the masons come forward, hollow out the shapeless

FESTOON OF WAX-WORKERS.

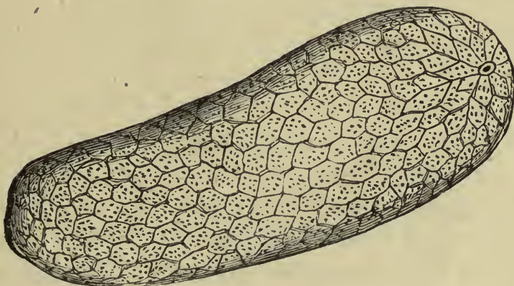
lumps, and mould the bottom of the first cells. Fresh supplies are brought, and soon the comb begins to take its shape; the hexagonal cells, of the thinnest possible consistency, being all laid horizontally, back to back.

While some are extending the foundation of the comb

right across the hive—for bees always lay their foundations at the top and work downwards—more wax producers are adding little lumps of wax, like masons' labourers bringing materials for the comb-builders, whc

COMMENCEMENT OF COMB.

without rule or compass fit all with the most minute exactness, and the work proceeds with wondrous rapidity, several thousand cells being sometimes formed in a day. One set of bees shape out the bottom of the cells, roughly moulding the six sides. Others, whom we may call finishers, succeed them, and beat out the wax with their



AN EGG MAGNIFIED.

mandibles till it is as thin as tissue-paper, and plane down all the roughnesses.

In a day or two there is accommodation provided for the eggs which are the hope of the colony, and pollen

and honey are being collected for their support so soon as they hatch, which is in about seven or eight days after.

But the cells are not all of the same size. About a tenth of them are larger than the others, though of the same shape. These are for the drones or males, and it is strange that the instinct of the queen, who creeps over the comb attended by her servants, and lays an egg in each cell, knows at once the difference between a male and a female egg, and drops each into its place. But the eggs of the queen in no way differ from those of the workers. It is not till the swarm has been housed for a week, that the bees build a few thick circular cells projecting from the edges of the comb, to receive eggs which are to be royally reared, so as to provide against any calamity befalling the reigning sovereign. It is a large hive which contains twenty of these cells, and the queen only drops an egg into them at intervals, lest too many claimants should emerge at once.

But let us now return to the old hive, and see what has taken place there since the departure of the old queen on her voyage of discovery.

The young queens whose threatened advent so alarmed her, have not yet left their nursery. Nor will the nurses who so courageously defended their charge allow them to do so yet. As they break through their waxen lids they build it up again, but pass a little honey through an opening, to keep the young lady quiet till they see fit to let her come forth.

No sooner has she emerged, than, like some Eastern

potentate, she inaugurates the new reign by searching out and slaying her nearest relations, rushing from one queenly cell to another, and trying to kill the imprisoned inmate. The nurses vigorously resist, and if the hive has increased sufficiently to cast off a second swarm she is allowed to follow the example of her mother, and lead forth another party of emigrants. If not, she is permitted to glut her jealousy on those furthest advanced towards maturity. She tears open the cell, and at once stings the helpless prisoner. As soon as she has gone in search of another victim, the workers also enter the cell, and drag out the carcase of her slain rival.

When all are slain, the queen remains quiet, and devotes the rest of the season, till the approach of winter, to the laying of eggs, at the rate of 200 a day. But in a month or two a new massacre begins.

At the approach of autumn, economy becomes the cry. There must be no eaters who are not workers, and the helpless, stingless males, whose work is done, have to be got rid of. The drones are pursued from one part of the hive to another, set upon by the workers, and stung to death. Their carcases may then be seen strewn by hundreds on the ground near the hives, where they have been dragged out and dropped. Not even the larvæ or pupæ of the drones escape. The cells are torn open, the young ones pierced, their juices sucked, and the bodies thrown out. It is only if any accident has happened to the queen, and the nurses are carefully rearing some half a dozen in royal cells, from

whom to choose a successor, that the drone pupæ are allowed to live.

If a queen perish or is lost, and there are no royal cells, or none with eggs in them, the workers at once build several proper cradles and remove some of the newest laid female eggs into them to be reared for the throne. The moment the first hatched comes forth, she is at once surrounded by crowds of courtiers, who brush her, lick her, serve her with honey, and attend her every movement, while all stand aside respectfully in file as she passes to and fro.

Such is bee life. And who can throw a stone at either its policy, its industry, or its architecture? Yet these busy insects are not toiling for themselves alone. Their labour is consciously for the community, unconsciously for us also. The supply they store in summer is far more than is needed for their own wants. Why, then, should we not be content with a share, and leave the hive to work for us another year?

We all laugh at the man who killed the goose that laid the golden eggs. Yet this is exactly what too many beekeepers do in England. Instead of levying a tax on all their hives, they leave some untouched, and destroy the heaviest and the best worked by suffocation. This is one reason why we have so few bees compared with most foreign nations. To smoke their bees is a barbarism which would horrify the Syrian or the Greek.

It is very easy to get the honey without killing a bee, or running the risk of a sting. Seventy years ago

it was discovered that the smoke of powdered puff balls lighted under the hive will stupify the whole swarm for some minutes, so that the hive can be examined, and the combs with virgin honey cut out, the pieces with young bees and pollen being left or replaced. The same effect is just as easily and safely produced by chloroform; and the bees recover without any injury so long as they have not been too long exposed to it.

Let us hope ere long bee-keepers will learn to combine humanity with profit, and will as soon think of smoking their bees as of burning their hayricks.

WASPS AND PAPER-MAKING

WASPS AND PAPER-MAKING.

Part I.

"YOU or I, fair damsel? you or I? For which of us is that sweet fruit ripening in the summer sun? Day after day you come before any one else is awake, and gaze upon it, and as you watch its delicate hue mellowing into the rich colouring of its perfection, you say to yourself, 'To-morrow! to-morrow I will pluck it.' But you shall find to your cost that one has been there before you. Look to it, for I am armed, and, once in possession, I know how to hold my own. Let every one, man or insect, look out for himself."

Thus hummed and buzzed to himself in selfish soliloquy, a brilliant black and golden insect, hovering near the garden wall; now wheeling in airy circles, greatly to the terror of the gentle child who attempted to approach the tree; and now settling on the luscious fruit to thrust in his proboscis, for the purpose of making

his temporary abode inside the mellow peach, so soon as it appeared to his fastidious senses to be sufficiently ripe for the attack to be made. Sorely terrified was the little girl, who, standing on tiptoe, just ventured hastily to touch the fruit, and thought, "To-morrow! to-morrow it will be quite ripe, and then—— Oh, dear poor Janie! and then—— Oh, how she will like it!"

To-morrow! To-morrow! Alas! to-morrow brings with it many unlooked-for disappointments; and yet how strangely mixed sometimes with the signs of a worse evil averted! The wasp had its work set him by his own greedy nature, and ensconced at length in a cavity scooped out by his own exertions in the side of the peach, settled himself in conscious security, armed, as he thought, against all intruders, and feasting on the luscious dainty so long coveted by him. Did any relentings beset him, as to the sting he was preparing for those fairy fingers, when they should be extended to pluck his dainty morsel? Could he not have wished it were some selfish greedy creature like himself? perhaps some tyrannical schoolboy, at home for the holidays, full of the conviction so common among boys, that all good things ought to go but one road, or at most two, into their own pocket, or down their throat; and that but one crime exists in the world—that of depriving them thereof.

WASP AND FRUIT.

Whether or not the actual turn in the tide of affairs was any real satisfaction to the moral sense of the insect, it will doubtless be so to us, as we turn at the sound of rapid footsteps, not lightly tripping as we expected, but heavily pounding the gravel-walk, and, rushing up to the tree in hot haste, we recognise the identical being of our imagination. No, we will not wrong the British schoolboy; it is the spoilt child of a foolish home, who, having heard of his sister's secret and loving longings to carry the peach, as soon as it should be ripe, to the bedside of her suffering friend, resolved to be beforehand with her, and secure the fruit for his private eating.

Who can pity him? Who does not rejoice, and cry out, "Served him right?" "Glad it was he who got stung."

Yes; listen to him, how he yells! See how he dances about, flings his fingers from him, as it were! and then seizes his cap and makes a dart at the wasp, determined to kill the creature whose only crime was being there before *him*.

And who will pity the pitiless boy? Who comes up at the moment? Her face beaming with hope, she sees the fruit gone—dashed to the ground—her cherished pleasure snatched from her, and yet has hardly time for the tear to gather in her eye, or the grieved tenderness of her heart to find expression in her face, when the tone of anger and the flush of selfish disappointment on her brother's countenance distract at once her atten-

tion from her own trouble, and she hastens to soothe the rage, and to use such remedies as she can. Ah little girl, we are so glad the wasp stung him instead of you; and, though you have lost the peach you were waiting for, see, there is another hanging close by among the leaves, which you may safely gather now, for I think *that* wasp has left its sting in the proper place, and is not likely to trouble any one again.

But why were wasps made with stings? and of what use are they in the world, even if they had no stings to make them a terror to the selfish and the cruel among human beings? They make no honey for the delectation of the lovers of sweetness—no mead for the libations of our ancestors was ever manufactured from the secretions of their industry. For what benefits to society from their labours are we indebted to these irascible creatures, whose very appearance at the breakfast-table has the effect of a bombshell in dispersing the company; but who seem to have hitherto failed to establish a claim to respect or affection, or even to have exhibited in their instincts any model on which more rational creatures may improve in their elaborate efforts after comfortable homes or luxurious living?

No honey—no wax—for they must die with the season which gave them birth, and the cells they inhabit for the brief space of their existence are of far less durable materials than those which we see in the structures of the honey-bee. Yet, for delicacy of structure, for minute elaboration of its material, for exactness

of adaptation to all their wants, the nest of a wasp will never suffer in comparison with that of any other living creature.

Fragile in the extreme, it is always protected from attack by its situation, or concealed underground at a distance of more than a foot from the surface; and like the nest of the bee is furnished with rows of cells, for the habitation of the workers. A question seems to arise as the process is examined, whether the wasp exists to build his nest, or the nest is built for the existence of the wasp, since his life is extended so short a period beyond the completion of his work.

But nests have served for several generations of wasps. One especially was long preserved under a glass case in the drawing-room of a house which had for years been infested by these irritating insects, whose resort no one could discover, until the repair of a disused chimney led to the discovery of one of the largest known nests, which the wasps had inhabited, repaired, and enlarged for years.

The character of our wasps has greatly suffered at the hands of prejudice. They are doubtless armed against attack, and are justly feared when the ripened fruit hangs daintily in presence of the creatures, both of human and of insect life, for whom, doubtless in common, such feast is bountifully provided by the great Lord of Nature.

But *who ever* saw a wasp attack a wasp? They all work in harmony; nay, more, they are very good neighbours to many other creatures. For instance, one of our ground

wasps always makes its nest in the close neighbourhood of one of the humble-bees, and no one ever knew the wasp, sweet though his tooth may be, help himself from his neighbour's store-room, but he honestly goes out and caters daily for himself. Indeed, the wasp has been hardly dealt with in being held up to hatred as a *waspish* creature. He is not so 'waspish' in his temper as his cousin the bee; and though he has not the character of being a hard-working labourer, yet he is ordinarily far too busy in getting his daily bread to turn aside and waste his time by picking a quarrel with the passing stranger.

When he comes into the breakfast-room, drawn by savoury odours of jam and preserve, he only asks for a share; but when every handkerchief is flashed over his wings, and when ferocious attempts are made to crush him, when, in his hurry to beat a retreat, he has struck against the window-pane, his temper would be more angelic than even a wasp's can be expected to be, if he did not retaliate by attempting to use the weapon with which Nature has endowed him.

But we can examine a wasps' nest with far less risk than a beehive, if we do not irritate the inhabitants by too officious a curiosity. When a scorching summer's sun has quickened the energies and somewhat tried the temper of the busy colony as they pass to and fro, we must not stand in their way, and we must beware of treading on some wearied insect crawling home on the ground, and too weak to fly, though quite strong enough to sting with effect.

There is, however, a great difference in the temper of

the different species of wasps, as we are told by those who have studied them. The large British wasp, which builds in the ground, is said to have the sharpest sting; the wood wasp, which hangs its home in the bushes, and is very common in the north of England, is the most ready to use its sting, probably because, having so conspicuous a nest, it must be most alert in its defence; while the red wasp is said to have the most amiable and inoffensive nature of all, and to hold the place among wasps that the humble-bee does among bees.

Of course, when foes take their nests, any wasps will sting if they have a chance. Their devotion to the home they have built by their own mandibles is very strong, and even the loss of their queen will not drive them from it. No wonder, then, that like other creatures they have great repugnance to being disestablished and disendowed. They will bear many things for peace' sake, but they would not be wasps to stand this. When, however, the wasp-hunter, safely protected by his veil and strong leggings, has succeeded in digging up the nest of the ground wasps, or cutting down the branch with the nest of the tree-wasps, he may carry it where he will, and the little republic will cling to it still. He has only to place it where they can have easy access and work at leisure, and they will soon begin to repair damages and to feed with devoted attention the young larvæ in the combs.

But, after all, if we do leave them alone, what is the use of these dangerous little creatures, who will *not* leave

us alone if we disturb them in gathering the plum or the gooseberry we have been cultivating for ourselves?

We shall soon find, if we will only study the life of a wasp, that it deserves to be reckoned among our real benefactors. If they take toll of our gardens in autumn, they have been really working for us in spring. First of all they are active scavengers. No vegetable matter, no decaying garbage in which the vinous fermentation has commenced, comes amiss to them, and they clear off much that would otherwise taint the atmosphere. So also they gather a great deal of rotten wood. But besides this, they have a very carnivorous appetite, and devour spiders, flies, and especially caterpillars, those enemies of the farmer and the gardener. Dr. Ormerod, the charming historian and champion of the wasp,* brings forward instances in which the careful destruction of wasps has in a year or two resulted in infesting the place with Egyptian swarms of flies. About a wasps' nest the wings of flies and other insects may be gathered in handfuls; in fact, they form little insect kitchen-middens.

Almost every one is aware of the mischief which is done by killing off the larger animals—as for instance the kestrel and the owl, who destroy millions of rats and mice—lest they should occasionally fall in with a wounded partridge. The sea-birds, who used to be butchered by every stupid fellow that could borrow a gun when out for a holiday, were found to be so useful to the sailor and

* "Natural History of Wasps." By E. L. Ormerod, M.D.

even the fisherman, though they eat fish, that at length they are protected by law.

But in the case of these larger creatures man can by contrivances do something to supply their office. In the case of insects he can do nothing, though, happily for him, they are too small and too rapidly propagated to render his ignorant efforts for their destruction successful. and so the wasp still lives in spite of gardeners and their boys, and helpers, whose whims and prejudices would long since have doomed him to the same fate which has befallen the noble peregrine falcon at the hand of the gamekeeper, if the power of gardeners had been equal to their will, and their decision final.

Now if we can only persuade the gardener to observe the wasp in spring, at the very time he is most energetic in its destruction, we shall soon convince him that he has in it a true friend. With the bright sunny mornings in April, the old queen wasps that in some sheltered cranny have survived the frosts of winter, come forth, not like lone widows, but the royal foundresses of new kingdoms.

We may see them then busily occupied on the slender twigs of the gooseberry bush, or in the young wood of the apricot. There is no fruit for them there to pierce; they are feasting on the aphides and the mildew insects, which the gardener with all his syringes and decoctions of tobacco-water cannot subdue as the wasp can. Wherever these minute little pests most abound, there you may see the wasps' mandibles hard at work, carefully clearing off all the gummy exudation till the top of the young

bough is reached. If the red spider or its eggs come in her way, the wasp uses them with much relish as her *sauce piquante.*

One wasp unmolested will thus, in a day or two, by free work clear the insect pests from a whole tree, and will secure the owner that crop which he never could have had without her aid, and on which surely she may put in a claim for her future family to take tithe. It is scarcely possible to calculate the number of aphides which a hungry queen wasp will thus devour in the spring and early summer months.

WASPS AND PAPER-MAKING.

Part II.

BUT it is as the original paper-maker that the wasp's most marvellous instinct is displayed.

Excepting in the shape of its cells, there is nothing in common between the wasp-nest and the beehive. The architecture, the material, the position, the arrangement, the uses all vary in the two families. All bees make their combs of wax collected by them from plants, and kneaded. All wasps are paper-makers, not wax-collectors. The comb of the bee is destined for various uses—to be the home of eggs and larvæ, or young bees, to hold either honey or pollen, and is also intended to last for many seasons. The comb of the wasp is built but for one year and for a single purpose—to contain the young from the egg till it comes forth a perfect insect. Then, while the cells of the bees' comb are arranged back to back in the same comb, which hangs

vertically from the roof of the hive, the wasps' comb is suspended horizontally by a pillar in its centre, and is composed of a single layer of cells, all opening downwards.

There is one point in which the wasp shows greater architectural power than the bee. The latter trusts to nature or to man for its hive. The wild bee finds a hollow tree or a crevice in the rocks, in which the combs may hang protected from the weather. The wasp, not content with manufacturing its own household furniture, builds the house also for itself, and that of the same material, and relies upon her own exertions to defend herself from the effects of wind and rain.

The wasps, like the bees, comprise prolific females or queens, barren females or workers, and males or drones, which, among the former as among the latter, are stingless.

But the lives of the queen wasp and the queen bee are very different. The queen bee, from that sunny morning on which, like some Viking of the North in olden time, she set forth to found a new empire on new soil, with the swarms of her attendant and devoted subjects, never again leaves her palace, far more closely immured within it than any Eastern sultan or Japanese Tycoon, until she has done her life's work, having known no labour save that of depositing myriads of eggs. But then she is founding a dynasty, and her little kingdom may be handed down in the female line for many gene-

rations, unless prematurely extinguished by the hand of the spoiler—man.

How different the life of the queen wasp!

Like some hardy colonist, she goes forth in early spring into the wilderness, the lonely and solitary survivor of her family, with no obsequious damsels crowding round her such as those that throng the court of her more dusky cousin. She has no parental roof-tree which is hers by succession. No inheritance has come down to her, but, like the human pioneer in the new land, she must cater for herself. She must be her own architect, her own mason, her own gardener and purveyor, and this too with the cares of a family coming on, and all her youthful progeny, swathed and helpless, dependent on her sole exertions for everything.

During the winter she has lain torpid behind some shutter or cornice, in the crevice of an old wall, or under the shelter of a roof, in the cranny of a chimney-stalk. With the first warm mornings of April she comes forth, very often to perish prematurely by the cutting spring frosts, and keenly chased by the hungry starlings and the gardener's boy. Few of her race have survived the blasts of winter; and of those that have, fewer still run unscathed the gauntlet of all their enemies. And still for weeks she must remain alone and unaided, with food to seek, a home to find, a nest to build, and then all the hungry grubs that soon follow to feed. She does not hurry about beginning her nest, but takes a long time in selecting her house.

There are six kinds of wasps in England besides the hornet, which is in reality only a large species of wasp; and of these some build in the ground, in holes, or in fissures of rocks; others hang their nests in trees or among bushes. Whatever be the situation, the nests of all our species have much in common. They are all built of paper, made by the insect itself, and whether hanging from a bough with the paper dome that shelters them from wind and rain, or snugly suspended under a roof beam, hidden in a hollow tree, or excavated in a bank-side, the nests all begin and go on in the same way, adapted, of course, to circumstances. The tree wasps take care to have their dome smooth and rounded to carry off the rain at once. The hornets make a stout case when their nest is exposed, a very slight one when they choose a hollow tree or similar shelter. The ground wasps make a strong, rough, coarse, brown paper shield underground, but a much firmer and lighter shell when they build, as they sometimes do, from a rafter.

But how do the wasps get their paper? They manufacture it.

Long before the Egyptians had discovered how to pare papyrus stems into shavings to make their books, before the Chinese had learned to squeeze and spread out the thin cotton pulp into sheets of paper, the wasps knew how to apply almost every substance which has been employed by our paper-makers to the fabrication of their dwellings. Grass fibres, withered leaves, rotten

WASPS' PAPER, GROUND AND TREE-NESTS.

wood, paper cuttings, bark scrapings, the thin coating of buds, vegetable down—all these and many other substances are worked up by the wasps, and laid on precisely in the same manner by all.

If we watch a wasp on an old gate-post, we shall see it peeling off little strips of woody fibre, which she rolls into pellets and carries home in her mandibles. There are also many kinds of rushes and water-plants, the stems of which are covered with tough filaments, which the wasp peels off, and which make papier-maché of a stronger and superior quality, much more proof against the rain than the wood scrapings. As soon as the busy insect has rolled up a good-sized pellet of wood or grass parings, she tucks the burden in and under her mandibles or large pincer jaws, and with outstretched neck flies home.

Then, on arrival, she first retires within the nest to rest for a minute, and coming out again promptly sets to work. If what is required be the strengthening or enlarging of the outer walls, she gets astride the edge of the shell of the nest, takes hold of the pellet with her fore-legs, presses it down firmly, and kneads the end of it, fastening it with her gummy saliva, and then slowly she walks backwards, unrolling the pellet as she goes, pounding and working it firmly down, while keeping it moist, and when she has come to the end she runs forward again, and commences to retrace her steps, drawing the edge through her mandibles, flattening and kneading it as she goes, and repeating the process several

times till the little addition she has made is evenly and neatly welded on to the structure, and as soon as it is dried cannot be distinguished from the former work. The nests often have a striped appearance, caused by different wasps bringing materials of different colours, and working in their own quota as they find a vacant place on the edge of the nest.

But the first commencement was very humble. The queen began in spring by attaching a little cap of grey paper, of the shape of a tiny parasol, to a stalk of paper gummed securely to the under side of a branch or stone. Below the cap this footstalk is extended and spread out to form the beginnings of four little octagon cells, hanging downwards, in each of which she drops an egg, and glues it into its place. The lonely lady then begins to enlarge the cap, and adds other cells on each side of the first, strengthening the foundation pillar as she proceeds. Her labour grows upon her.

The first eggs hatch, and now she must feed her young and go on with her house-building at the same time. She busily flies backwards and forwards to the nearest bushes, and hurriedly gathers a supply of juicy aphides or well-fatted spiders to support her larvæ.

At length the first brood is hatched (though by far the greater number of nests begun never reached this stage, owing to the precarious fortunes of the mother), and then the queen begins to assert her dignity, and to rely upon the labours of her offspring. The nest is soon brought into shape, and the covering drawn down and

completed underneath, so as to form a perfect sphere, with a small hole near the bottom for an entrance.

But the original work must be rapidly undone. There is no room for enlargement within, and therefore one outside cover after another is added over the former, each quite independent of the preceding layer, which is removed from the inside, as the outer cover is completed.

Meantime the comb inside grows apace, as fast as the walls expand. The four original cells grow into a comb, with six or seven combs, hanging layer beneath layer, each perhaps six inches or more in breadth; and the pillar, which is the centre and key of the work, is proportionally strengthened, and the strips of paper which attach it above are doubled and trebled to bear the additional weight. As the comb grows, every day the inside of the case is cut away to make room for it.

Thus the quantity of paper used is very great, for the cuttings of the old are not used again, or, if they are, it is only after they have been nibbled and reduced to pulp again by the jaws of the workers, and then mixed with new material. The floor of the nest is thus always strewn with scraps of used paper, as that of a beehive with waste wax-plates. Sometimes, too, the wasps scamp their work, and if they find leaves at hand that suit their purpose, they will work them into the nest without any previous manufacture.

WASPS AND PAPER-MAKING.

Part III.

MANY foreign wasps—and the species of wasps are countless—differ much in their architecture from those of our own land.

Some, in countries exposed to much rain and wind, make their paper stout, thick, clean, and white as cardboard—so strong that it may be knocked about and washed with impunity. The cardboard is made of the finest cotton down felted together, and as many as sixteen or more layers may be counted forming the walls of the nest. This wasp lives in Demerara, where the sudden and violent rains would soon wash away the whity-brown fabric of the British paper-maker.

In the East Indies, where rain hardly ever falls during the lifetime of the wasp republic, a large species is content with mud with a little straw mingled, like the bricks at which Israel had to toil in Egypt, and makes

a huge clumsy structure, which one heavy thunderstorm would reduce to a hopeless wreck of mud. Others, again, use only leaves, and are tailors rather than paper-makers Others make no roof at all, and some hang their combs with a paper umbrella over them, but no flooring or other protection. One species contents itself with using a great leaf for its cover, while it makes its cells of paper.

In the Holy Land, again, there is one species which hangs its combs in cavities in the sandy banks of rivers, and which, suspending its great comb from the roof, economizes labour by omitting all covering, while it prevents any injury to the comb by running a thin irregular sheet of very fine whity-brown paper along the under-side of the roof of the cave, so that no sand or pebbles can fall on to its nest.

Dr. Ormerod tells us also that wasps can foretell the weather with a preciseness far superior to that of the most skilled of almanac-prophets.

A gamekeeper in a land of brooks informed him that the height at which wasps make their nests above the water is a rough index of the amount of rain that is to be expected during the summer. In a wet season they choose the top of the bank, in a dry year they excavate nearer the water level. Again, it is found that when a hedge bank is selected, instead of the more ordinary situation, the edifice is much slighter than when wind and rain have to be provided against.

But still, under whatever conditions built, we can

always recognise the difference between the architecture of the different kinds of wasps. Besides the hornet, which is only a species of very large wasp, and must always be counted with them, there are three kinds of ground wasps, and three of tree wasps, in Britain. Each species makes a distinct sort of paper, and we have only to hold it up to the light, to read the water-mark of nature's impressing, and we can recognise the builder.

The hornet, for instance, who does everything on a large and coarse scale, makes its paper very thick and brittle, of a yellow colour, composed of fragments of decayed wood, bits of straw, and other rubbish glued up with sand into a coarse pulp. There is a good clear space, inside the hornet's nest, between the combs and the wall, like the open space that used to be kept in Vienna and other fortified towns between the houses and the walls.

The common ground wasp builds on the same plan, but its paper is a very superior sample. It is much finer, the fragments of wood are much more carefully beaten into pulp, and instead of being yellow, the colour is much more varied, generally with stripes of whitish brown. This wasp will build anywhere where it can find shelter. Though generally underground, yet a good cottage roof, especially if it be thatched, never comes amiss. It has even been known to build attached to a sugar-loaf. This last was rather an extravagant use of the loaf for a wasp, since it usually prefers to take the sugar inside.

At least we have read of a Government sugar store in India, which was taken possession of by a swarm of hornets, and held by them in defiance of the order of the East India Company, till the end of the season, when on the commissariat officer claiming his charge at last, he found they had got through two thousand pounds of sugar. We must confess that the paper of the ground wasp is not of the strongest quality, and would not be at all appreciated in the grocer's shop.

Our other common ground wasp makes a similar nest, but it can always be distinguished by having no mottling or stripes of colour in its construction, but is of a uniform dull grey colour, and in texture is not more stout or durable than its cousins. It easily comes to pieces, though there is no stint of material in its construction, but the layers are heaped on overlapping each other, and without the neatly-trimmed edges which mark many of the others. There is generally a neat little mouth, with a landing-place and porch at the entrance of this nest, which is always near the bottom of the building.

Much prettier is the ground nest of the red wasp, which lays on the plates of paper very neatly, and with the edges smoothly tacked down.

The tree wasp makes much larger sheets of paper. *Vespa britannica*, the commonest tree wasp in the south of England, makes its nest of much better paper, for it uses stout vegetable fibre instead of rotten wood in its construction; and, indeed, it requires a much stronger

material, for the nest hangs exposed in a bush or hedge row, open to all the changes of weather. The paper is prettily mottled with white, brown, and yellow streaks.

One other tree wasp, which is very common in the north of England, makes its nest generally of paper of one colour, but very tough, and hanging loosely, like petticoat flounces, one over another, in a great many layers. The hole of this nest is always exactly at the bottom. This bell-shaped nest is, I think, the prettiest of all.

The internal domestic arrangements of all these species of paper-makers are the same. The eggs, we have said, are glued to the bottom of the cell by the mother wasp, or else, of course, they would drop at once out of the inverted cup.

When hatched, the tail of the infant remains glued to the top of the cell in its old egg-shell; and though it moults several times, still its tail remains glued until it has nearly reached its full size. But it often becomes detached, and then the workers, who have no toleration for untidiness, and treat everything that is out of its place as dirt, are sure to carry the little larva away without pity, and eject it with other scraps and rubbish —a fearful warning to other baby wasps to keep in their cradles.

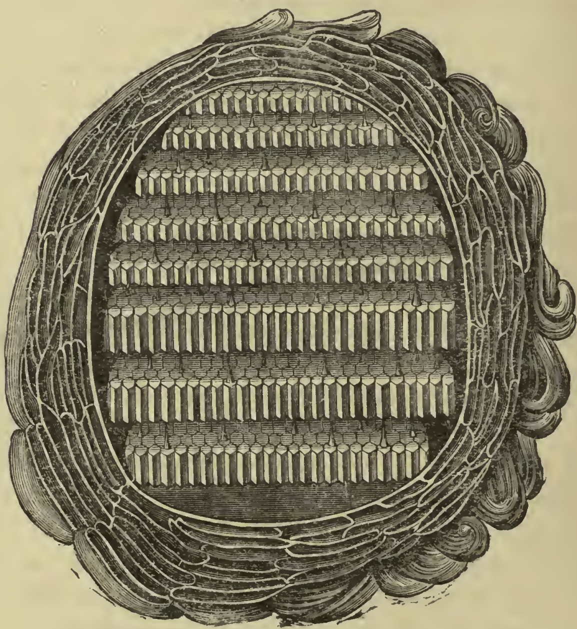
As soon as, after various moultings, the little larvæ have attained their full size, nearly large enough to fill the cell, but still able to turn round in it, they begin to weave a silk case, which is to protect them

while they change to the pupa or chrysalis state. This done, they weave a white silk cap on the bottom of the cell, and then cast their skin a second time.

It is curious that the wasp larvæ have sharp mandibles, with which they mince for themselves the food brought them by their nurses. They get a new pair with their new moult, which are used at the end of their chrysalis existence to cut their way into the outer world. As soon as the newly-awakened insect has cut its way through this nightcap, it begins to feed itself, and actually eats its slight dress piecemeal, directly it emerges from the cell a full-grown, pale-looking wasp. Soon its wings expand and dry, and it sets to work at once at paper-making, as if it had long since served its apprenticeship. Meantime all the old silk casing and other loose fragments are cut off the empty cell, and it is considered ready for a new-laid egg, though much dirt may be left at the top, which is never thoroughly cleaned out.

I must give the history of the growth and end of the wasps' nest in Dr. Ormerod's words :—"By the conjoint labours of all the busy workers, here a little and there a little, the nest grows. The work of one week may have to be renewed the next week, to make way for modern improvements and for the requirements of the growing city; and, as we have seen, it has nearly all to be done twice over. But wasps work very hard, and the nest grows visibly day by day. The little egg-shell in which it began is lost in the changes which the top of the nest undergoes. The slight strap from which it hung is now

quite inadequate to sustain the daily increasing weight, and new points of attachment are sought to projecting roots, or stones, or branches. Sometimes a branch runs



THE INSIDE OF A WASPS' NEST.

all through a nest. Or, failing these, the original point of support is strengthened by layer upon layer of paper rubbed smooth, and thickly coated with wasp gum to

perserve so vital a point from all accidents of wind and weather. . . . .

"One thing more British wasps' nest have in common, viz., the end of all their labour, the wreck and ruin of their wonderful fabric. The history of the most long-lived swarm of wasps extends only over a few weeks. The end comes very speedily, as well as surely, whatever the cause, and the story of the decay of the nest, whose growth we have traced, may be told in a few lines.

"No additions are made to the structure, the repairs are neglected, the loose ends are not neatly cut off and fastened down. A few idle wasps hang about, but the nest seems almost deserted. Perhaps a shake of the hedge will bring out a few fussy wasps for a minute, or a sunny afternoon will develop signs of life in the remains of the swarm, yet their strength is gone. A cold night or two, a few damp cold days, and all is over.

"Now the collector takes his prize safely; but he must be quick about it, for if he delays, the rain and wind will soon destroy whatever of this curious structure the moths and wood-lice and earwigs have spared. These are now its occupants. The little creatures who made it, and held it against all comers, have succumbed to cold, and disease, and old age, like other brave soldiers. They have skulked off to die, like old cats, away from home, and the most unlikely place to find a live wasp is in an old wasps' nest." *

So much for the story of paper-making and wasps.

* Ormerod, "Natural History of Wasps," p. 209.

Much more remains to tell, for wasps yield not to bees in interest and in display of forethought and instinct which can never be explained but by reference to divine provision. But I hope I have told enough to lead my young readers to look on a wasp as something better than a "horrid nasty thing," to be crushed on the window pane or trodden underfoot whenever there is a chance.

SILK AND SILKWORMS

SILK AND SILKWORMS.

Part I.

"A LONG pull, and a strong pull, and a pull all together," was the practical language of the thousand and one slender fibres of the silken cord, strained and tightened from the bell-wire, which the master of the house pulled with a vigour and determination that bespoke attention, and with a result that might have awakened the seven sleepers.

"You'll break the rope!" was *our* exclamation, instinctively closing our ears with our hands: "you'll certainly break the rope, it's only *silk*."

"*Only* silk! and what more, and what better would you have for strength, for elasticity, for carrying weight, or bearing a pull? Look at little Madge at the table, winding away off her cocoon, and tell me what other material in the world for its size is half as strong. Talk of a hempen rope, an iron cable, you might as soon

make use of a rope of sand, if either of them were taken in the slender form of that little thread; but *twisted, combined*, made into a cord, I think we have something far more telling than even the old fable of the bundle of sticks as to the strength of *united* action."

"O for united action now!" Was it not the voice as of a plaintive and much-injured being, issuing from the glistening thread, that many times already had snapped under the impatient hands that attempted to wind it? "Had I but my ten sisters here to twist and twine their threads with mine as erst so lovingly we fed together on one mulberry bough, I had not now to endure alone the impatient shocks that shiver my whole being and send a tremor from end to end of my thousand yards of length."

"Tiresome thing!" exclaimed little Madge, whose single thread of silk from the one cocoon which was her own especial property, had, notwithstanding all the elasticity so truly attributed to it, snapped now once too often for her impetuous spirit, and on whom the above valuable suggestion had been entirely thrown away, probably because entirely inaudible. "Tiresome thing! I *won't* go on! *I'm sure it breaks on purpose!*"

"And a good purpose too, if it were to teach you to twine a little patience and perseverance with the slender thread of a little objectless amusement; the threefold cord would stand a stronger pull than that which broke your silk, and that, slender as it was, would have given

you no disappointment if you had consented to the wish of the others, to wind the three cocoons together.

"But while your patience has time to recruit itself, come here and listen to a silkworm memoir which I happen just now to have met with; just such a history as the little being inside that cocoon might have uttered, could it make itself understood by us:—

"'Like all beings, clad not in the rough and borrowed garments of the flax or of cotton material, but in the luxurious folds of their own ancestral silk, *I* boast a *very* long line of ancestry. *My* native land possesses a history older than that of any other nation on the face of the globe—a land where also the theory of the transmigration of souls lent encouragement to the hopes even of a silkworm, that the soul which had so rapidly been transmitted through its various and exciting transformations might one day fill the body of a Mandarin, an Empress, or an Emperor, clad once more in its primitive raiment, and walking erect on two, instead of crawling upon many legs.

"'Comparatively recent, that is, not quite four thousand years ago, were the days when the great Emperor, Hoang Ti, cast the eye of appreciation upon the labours and the lives of my progenitors, and his Empress, the inestimable Si Ling Chi, with the liliputian feet and the fairy fingers, first caused to be assembled within the precincts of her Celestial garden multitudes of the many-legged race, and gathered with her own hands the dainty leaves of viscid mulberry wherewith the voracious appe-

tites of the mothers of millions might be appeased. Strange were the transformations of their bodies, strange also doubtless the transmigrations of their souls, prefiguring the heights to which patient industry, even embodied in a grub, may yet attain. Yet it is recorded concerning their work and the productions of their lives, that evermore that which was most hidden and nearest the centre of their body was the richest and most highly prized, while the showy exterior and lighter surroundings were thrown away as comparatively worthless.

"'Nor was the celestial lady content with the task of benevolence which consisted only in ministering to the hunger and pampering the appetites of the army of insatiables; but as in China and among our own race all things human are reversed, so was her chief work of benevolence, not that of clothing the naked, but of relieving the overcharged and sleeping bodies of my ancestors of their superabundant clothing.

"'Up to that time the skins of slaughtered sheep sufficed to cover the human frame, and protect from the inclemency of wintry seasons a race who possessed neither the art of producing from their interior substance their external covering, nor yet the energy to condense within a single summer season the duties of a lifetime. But men were many, and sheep were few, and the cradles of our race were used by the Empress and her attendant ladies to enclose their own august persons.

"'Willingly we afforded to them the shelter no longer of use to ourselves, feeling abundantly requited by the

provision so liberally made for successive generations of our family in the planting of extensive groves of that paternal tree whence we derive, not only the strength of our constitution, but the texture of our raiment. Well it was that such care was bestowed on their nourishment, as otherwise it might have become necessary to resort to emigration.

"'Emigration indeed! that would not only have seriously lowered the self-respect of a race whose welcome has in every land, and in all times, anticipated their arrival, and who have never had to wander in *search* of a settlement, but have nevertheless entirely baffled the boast of our great patroness Si Ling Chi, who reserved the best and richest of her silken fabrics for the great sacrifice of Chang Si, and suffered not the outside Barbarians so much as even to see their grandmothers, or to handle the delicate threads they spun.

"'Then were we had in great esteem, then was silk worth its weight in gold, and then did the merchants trade with other lands for these precious things, making payment for the same in fabrics cunningly woven by secret arts from the many-threaded cocoons of the mulberry groves.

"'Rough and hard were the men of old, and wool was for them the fittest covering—best suited both to their unclothed bodies and their sordid souls. And of them the roughest and the hardest were the Romans; and of the Romans, one stronger and braver than many yet saw and coveted the strange softness and dazzling brightness

wherewith shine the garments of those who are clad in the cast-off raiments of our grandmothers. How must the great-grandsons of those noble old mulberry eaters have shuddered could they have witnessed the scenes enacted before the first silken curtain which Julius Cæsar spread over his tent in the Colosseum, where human gladiators and savage animals fought together as fight the tigers in the jungle, and the outside barbarians shouted at the spectacle! The show was brave, the silk was a gorgeous prodigality, and—Cæsar was a great man.

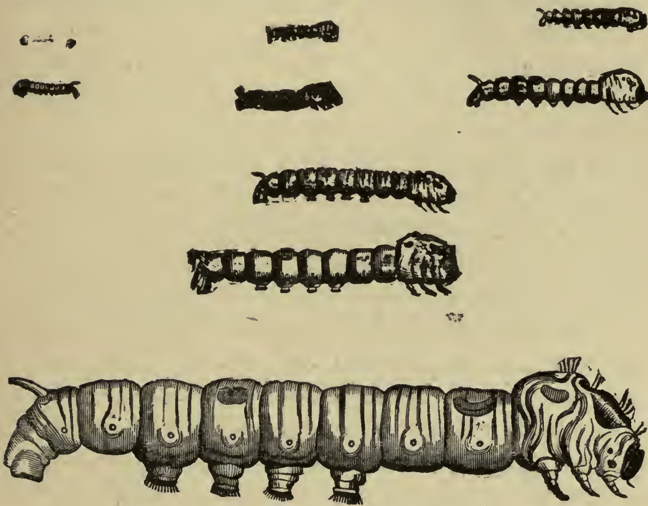
"'Yet did the Empress of the Celestials long outshine those of the West, for not even to the Empress Severina was the luxury accorded, so universally indulged in by the ladies of the little feet, of wearing a dress of a material so costly.

"'Still the natural desire of that half of the human race for costly, soft, and splendid attire was destined to be gratified by means apparently the most unlikely.

"'Clad in costume of dingy brown, the produce of the sheep or goat, and with no weapon but a staff, two men on foot invaded and succeeded in robbing of its precious monopoly the land that had hitherto cherished and protected us; and by ingenious concealment within those very staves, they imported in small numbers, and carried across the mountains and rivers of India, and the plains of Persia and Syria, the precious eggs whence should be hatched the successive generations of our now widely-extended family. Since that epoch, our pride of family, our exclusiveness in social position, have rapidly given

way before the revolutionary tide which has swept over Europe, and has even procured for the Barbarians of the West a settlement in the early home of our race.

"'No longer do emperors and empresses enjoy alone the privilege of wearing the produce of our labours. Not



THE SILKWORM'S DEVELOPMENT FROM THE EGG T[illegible] [illegible]TS F[illegible]LL GROWTH.

(Showing the four ages at which it casts its skin.)

only does the blue ribbon sustain the star of honour that distinguishes the breast of the British Mandarin; not only does the gorgeous train sweep gracefully round the person of the Royal Dame; the village maiden weaves in her golden hair a tress of brilliant silk; and even the

schoolboy, when he stoops to tie his shoe, fingers the ribbon that was once the work of a silkworm like myself.

"'My personal history is but brief, for not to silkworms is it given to con again in recurring seasons the experience of former years. With the early sun of advancing spring, I, who till then had been but an egg, and had lain tranquilly on a shelf through the bleak storms of winter, crawled into being, a slender black thread of life. Larger I grew, for future greatness dawned on my distant horizon; and, perceiving that the first, last, and only duties incumbent on a being like myself were to eat, to grow, and to cast my skin when too tight for my expanding body, I diligently pursued these avocations, and with a success that rivalled the largest, the most voracious, and most sluggish of my companions. Soon, a longing for change seemed to oppress me, and, as I raised my head to seek for new spheres of action, a torpor crept over my frame; I quitted the leaves on which hitherto I had feasted, and cast my lot as a dependent being on an isolated spot selected at random. But I soon felt the hour was come no longer to receive but to impart, and that in the process of giving forth of my substance, I was myself enriched. I have now for some time dwelt in the midst of a golden abundance; never hungering for food, and possessed of that wherewith I may clothe the needy. I shall now soon end my career, a creature different far from my small beginning; feeble, indeed, in flight, but prolific in eggs, and ready—after fluttering a few brief days a fair white moth, and leaving innumerable hostages to posterity

LARVA, PUPA, COCOON, AND MOTH OF THE COMMON SILKWORM.

—to enter upon whatsoever stage of transmigration the theories of Confucius may point out as the future of a perfected *Bombyx mori*.'"

So much for the autobiography of the little silkworm; but by what little things may the history of nations be affected!

When those two wandering Persian monks, of whom we spoke, contrived from the Indian Missions to penetrate the hitherto sealed empire of China, they discovered that the priceless tissues on which, at that time, the dainty dames of Byzantium expended princely fortunes, were not combed from plants or distilled from Oriental dews, but were the produce of an unsightly caterpillar reared from a tiny egg. So important did they deem the discovery, that, big with the secret, they traversed the breadth of Asia to lay it at the feet of the Emperor Justinian. Recognising its importance, he persuaded them, by right imperial promises, to retrace their two years' journey and bring back the precious eggs.

Rivalling in cunning the crafty Chinaman, they succeeded, at length, in filling their hollow canes; and those pilgrim staves, charged with a freight which has proved the seed of untold millions of wealth, and has changed the fate and industries of nations, in A.D. 552 were safely landed on "The Golden Horn." Long as they had remained concealed, the eggs were hatched at length, and fed and tended by the monks who had carefully studied their culture.

From the little family which was landed at the Golden

Horn have sprung, for thirteen hundred years, all the silkworms of Europe and of Western Asia. Long, however, did the Greeks retain the secret of their culture with a jealousy as vigilant as that of the Chinese; and it was not until eight hundred years had elapsed, when the Turk was thundering at the gates of Byzantium, and the fleets of Genoa and Venice were harrying the fairest provinces of the Greek empire, that Roger of Sicily carried off from the cities of Greece not only the silkworms, but the weavers, and compelled them to impart their mysteries to his subjects.

England had but small share in the silk of the East, for we read that the first time it was seen in this country was when the Emperor Charlemagne presented Offa, king of Mercia, with a royal gift of two silken vests. But from Sicily the culture soon spread over all the countries bordering on the Mediterranean where the mulberry-tree would flourish: and though Queen Mary forbade by law any person under the rank of an alderman's wife to indulge in a silken garment, and Queen Elizabeth was especially vain of the silken hose she received from Spain, the envy of her maids of honour; yet only a century later, in the reign of Charles II., it was the complaint of patriots, that every servant maid in London spent half her wages in silk, to swell the revenue of the king of France.

SILK AND SILKWORMS.

Part II.

IT is strange, and almost unaccountable, how, for so many centuries, the origin and culture of silk remained so profound a mystery. For though it is not mentioned by Solomon, and we do not read that his ships of Tarshish brought bales of silk along with the ivory and peacocks, yet the very earliest writer on natural history whose works have come down to us, Aristotle, the tutor and friend of Alexander the Great, has given us (B.C. 325) a very accurate account of the origin of the precious tissue. He tells us it is spun by a horned worm, which passes through many transformations, and finally becomes a winged moth.

But truth is often stranger than fiction.

The story that so beautiful a texture could be produced from a creeping worm was too absurd to be believed; and until the cocoons were actually spun in the West, the

tales of gossamers floating in the air, or combed down from silk trees, were thought far more reasonable.

There is no country which those little eggs from within the pilgrims' staff have so wonderfully transformed, as the old mountains of Lebanon. When Solomon was filling Jerusalem with all the strange curiosities of India, and the Holy Land was one vast garden studded with towns and villages, the long range of the Lebanon was one mighty cedar-forest; very valuable indeed for building temples and palaces, but inhabited by bears and wild goats instead of by men.

Now, all has been changed.

The cedar-trees have been cut down, and it is only here and there, in some wild corner, that the traveller can find them. The wild beasts have all been hunted away; and while the rich towns of Solomon have for the most part become desolate heaps, and the inhabitants of the villages have ceased in Israel, there are actually more people crowded amongst the valleys and rocks of the Lebanon than are now to be found through the length and breadth of the Holy Land.

The silkworm has done it all. It was soon discovered by the industrious Syrians, that the Lebanon was exactly the country which suited the mulberry-tree, on the leaves of which alone the silkworms could be fed. In so hilly a country, garden ground is very precious; but the mulberry-tree strikes its roots so deep, that they do not interfere at all with the crops of carrots, cucumbers, and onions which grow under the shade. Then, again, if the

GATHERING SILKWORMS' FOOD IN THE LEBANON.

worms are to be healthy, they must be fed on leaves grown in dry places; for though they will eat very greedily of the large succulent leaves of trees grown in valleys and wet places, yet they often suffer from them, and the silk is not so good. The noble cedars have all been cleared away, and the homely mulberry has taken their place.

Up and down the valleys the traveller passes for several days' journey along rocky mule paths, that are more like staircases than roads, with villages curiously hidden in clefts of the rocks; and churches (for the people here are Christians) stuck on to the sides of the cliffs, with their flat roofs covered with turf and grazed by kids, while rows of mulberry-trees swathe the mountains from top to bottom with closely-set waving strips of green. I call the mulberry a homely tree, for it is never allowed there to indulge its own taste for growth, but is pollarded to the height of from six to eight feet, whence springs a dense thicket of small shoots, very useful and convenient, though not very ornamental.

It is a bright and cheerful scene to visit the Lebanon in the height of the silk season. There is no school then for either boys or girls; all are too busy in attending to the hungry little worms. As we ride along we are startled by the cuckoo cry of a little urchin, ensconced in the centre of the dumpy pollard. There he sits, busily engaged in shredding the leaves within his reach, and throwing them to the ground, and his merry face, with his red cap and black eyes, peers from out of the foliage,

enjoying a saucy joke at the "howadji" as they pass Beneath, the little sisters of the family are gathering up the leaves and heaping them into sheets, while even the little toddler of three years old looks proudly conscious of the dignity of labour and employment, as she stumbles along with her little contribution to the common stock. The elder girls are staggering home under their bulky but not oppressive loads, and one taller than the rest stands on a pair of rustic steps, and strips the twigs that are beyond the reach of the merry boy in his nest.

But it is when the leaves have been brought home that the most constant care is required. In the garden behind each cottage stands a large wooden erection, a sort of stage of laths, thatched to the height of about six feet, with the green boughs of the oleander. The stage is full of trays from top to the bottom, which slide in and out, about six inches apart. On these trays the little worms are placed as soon as they are hatched.

Here is the station of the housewife from morning till night. She draws out the trays one by one, clears away the refuse, and picks out any diseased or dead insects, strewing the whole with the fresh-picked leaves which the children supply, and carefully screening the caterpillars from the sun, as they always feed on the underside of the leaves. The fresh green roof and the open-latticed sides secure abundant ventilation and coolness even under a Syrian summer sun. There, unlike the colder region of France, no artificial heat is required for the development of the eggs; and, from the first age to the

INTERIOR OF SILKWORM REARER'S COTTAGE.

fifth, the caterpillars continue to grow and thrive without any further care than air, food, and cleanliness, provided for them in this simple way.

In little more than a month, the worms, as tired of eating as a schoolboy towards the end of his holidays, begin to leave the trays and creep up the sides of the lattices. They are then left alone, and allowed to spin in peace and quiet on tufts of grass which are placed at the corners of the trays. And now the silkworm's life is ended, for scarce one in a hundred is allowed to leave its little case alive. A few of the cocoons are laid aside to be pierced in due time by the chrysalis, to supply the eggs for next year. The others are gathered and baked, lest the insect should eat its way out before the family have had time to unwind the silk. This unwinding forms the employment of the Lebanon household during the early winter.

The cocoons are laid aside until the grapes and the olives have been gathered, and then the process begins. It is there performed in a very simple fashion, just as children do it at home; about half-a-dozen cocoons being unwound as the children stand in a circle round the basin of hot water which contains a handful of the golden balls.

The little bobbins of silk are then weighed, and the village muleteer, when he hears that the roads are safe, and that there are no robbers in the neighbourhood, takes his precious freight to Damascus, and returns, if he is not plundered by the way, laden with the profits which are to provide all the simple luxuries of the village for the

coming year. For strength, for toughness, for solidity, the ladies tell us there is no silk like that of Damascus, and it is all grown by the mountaineers of Lebanon.

The silk bazaars of Damascus are among the wonders of the Eastern world, and many little arched streets run out of them, covered over from the light of day, where hundreds of hand-looms are busily employed in weaving the beautiful shawls and girdles which every Turkish gentleman wears round his head and waist, in which every English traveller who visits that eldest of the cities of the world is sure to invest all the cash he has in his pocket—if he have any sisters or daughters at home.

Of course, in more highly civilised countries, like France and Italy, the rearing of silkworms is carried on after a very much more scientific and artistic fashion; but I do not think it is nearly so interesting to watch as the happy industry of Hazrun, or any other village of the Lebanon.

In England, though we rear no silkworms, yet the silk manufactory is a very important branch of industry. Two important towns, Coventry and Macclesfield, almost depend upon it; and many thousands of industrious artisans are employed in Spitalfields, in the east of London, in the same manufacture. Our silk is chiefly imported from Italy, for the French weave nearly the whole of their own produce; but our silk-weavers are, for the most part, the descendants of French Protestants, who were driven from their own country by Louis XIV. at the cruel revocation of the Edict of Nantes.

which had promised toleration to the Protestants. That wicked revocation, whilst it deprived France of many of her best artisans, who fled in terror to other and freer lands, was the means of spreading a valuable industry, of which those who decreed that measure had little foresight.

A. THE BOMBYX MORI MOTH. B. ITS COCOON. C. THE OLEANTHUS MOTH.

The exiles brought with them improvements in the manufacture into England, and have enabled our silks to hold their place in the markets of the world.

Though the little *Bombyx mori* is the silk moth with which we are best acquainted, yet there are many other

silk-producing caterpillars. Some of these, which have long been cultivated in Japan, and are much larger than the mulberry moth, feed on the oak, and other trees more hardy than the mulberry. One of them, in the Himalayas, produces a silk which, under the name of Tusseh, is used largely for clothing in India. Another Japanese silk-worm, which feeds on the œlanthus, has lately been introduced into Europe, and produces a coarse silk scarcely inferior to that of the mulberry moth.

But there are other moths which spin silk in great abundance, though, unfortunately, without any consideration for the needs or tastes of mankind. Thus, in our fields, we may often see, in early autumn, a whole network of glossy silk, stretching like a canopy from the heads of the taller stems of grass, and covering a space of two or three square feet. This is the umbrella of what are called the umbrella-spinning caterpillars. They particularly dislike to expose their bodies to a shower of rain, and so, when they have found an agreeable feeding ground, they combine in spinning a screen which shall protect them from the sun and rain, while they devour at leisure the herbage beneath.

Akin to these, so far as they work in common, are what are called the sociable procession moths; the caterpillars of which may be often seen in oak coppices, marching by night in regular order like files of soldiers, all moving in exact order, one after another till they have found a feeding branch, and then returning before day-break with the same regularity. These creatures hang to

the stem or amongst the branches of the oak, large silken bags in which they remain secure during the day, lying heaped upon one another, till sunset calls them again to the march. But the silk of all these sociable moths is too short and scanty to be of use in commerce.

Silkworms, like larger beings, have many diseases, and many learned doctors have prescribed for their treatment. Some of these diseases appear to be very infectious, and three years ago an epidemic in Lombardy destroyed nearly the whole crop of the year.

They suffer most at the time when they change into their last moult, and it is then that the nurses are obliged to watch them most closely. Sometimes they writhe about, as if in acute agony, and at others they seem struck with paralysis. But I am afraid many of these diseases are the consequence of their own greediness, for it is the worms which have eaten most and become most fat, that fall victims to it. It appears that there is a curious microscopic fungus which takes root on their soft bodies, is nourished by their fat, and soon turns the living animal into a miniature mushroom bed. The animal soon turns red and dies.

The silkworm is not the only caterpillar on which vegetables seem to grow. We have had sent home from New Zealand numbers of extraordinary specimens, each consisting of a large caterpillar, hard as wood, out of which rises a stem six inches in length, at the top of which is the fructification and seed of a sort of moss. This sphinx of nature is, after all, only like a gigantic

muscadine, the name given to the silkworm fungus. Its little seed spores, floating in the air, attach themselves to the back of the New Zealand caterpillar, which is in the habit of burying itself before it enters the chrysalis state for the winter. The unconscious insect, little knowing that he bears upon him the seeds of death, descends in due time to his living tomb. As soon as he is under the earth, the spore begins to germinate, and, drawing all its nourishment from its victim, sends its shoot to the surface, and fills the whole of his skin with a hard, woody substance, which is its root, fed, not by the moisture of the earth, but by the flesh of the caterpillar. Its root never breaks the skin, and as soon as the whole body is exhausted, and transformed into hard fibre, the plant itself dies, and its seeds float in the air, till, perchance, one of them alights on the fostering back of another victim.

To trace the story of silkworms, the fate of their labours—whether to girdle a Sultan's waist, or to deck the skirts of an English lady; whether they are to form the hangings of a palace, or the marker of a pocket-book—would be far too long a task either to write or to read about in these pages.

Though the silkworm's thread may stretch for a thousand yards, I am sure my readers would like to pause before they had unwound the whole of it; still less would they have patience were our yarn to extend to half that length.

ABOUT FLIES.

ABOUT FLIES.

Part I.

"Little things on little wings
Bear little souls to heaven."

AND this is more than can be said of many of the greatest, rather let me say of the largest, of things; for greatness—true, genuine greatness—is not a thing of bulk alone, save as its elasticity can be alike compressed into the microscopic space of the quasi-invisible, or can fill a space which our minds can never take in. So also do we find the largest amount of utility in the smallest of creatures, while the hugest of beings leaves us in admiring doubt as to the amount of benefit conferred by it on the creation, which it seems to crown if not to adorn.

But what shall we say of the Fly, poor little thing? What use is it of in that "economy of nature," whereof philosophy boasts the power of explaining the hidden

workings and intricate machinery? To what extent does the buzzing creature, so ruthlessly poisoned, so suddenly dashed to the ground, preserve that "balance of being," which if once interrupted, as in the case of eagles and the falcons, avenges itself; as by the multiplication of the wild pigeons, rats, and other devourers of the farmer's produce?

To crawl on the ceiling; to buzz about our heads; to torment us by their numbers, and by their very littleness; to be guarded against by every possible manœuvre, avoided as pests, slaughtered by hundreds, or poisoned by the thousand—such is their daily lot; yet, when an incautious straggler visits your breakfast table, and throwing itself on your chivalrous hospitality for a sip from the cream bowl, falls a victim to its temerity, and you see it vainly struggling to escape from the white ocean of entanglement, how carefully, how tenderly, do you lift it thence, lay it in the sunshine, and watch its heavy limbs regaining their vitality! how do you rejoice in its escape, and triumph in its flight, though so soon to return, ungrateful wretch, to torment by its vagaries the fingers that erst so daintily spared its life; to haunt your gilded cornices and picture frames; and, finally, to fall unpitied, unlamented, a victim to the sugared snares which have proved fatal to the myriads of his brethren! Such is the episode in the life of many a fly, bringing it into contact with the tender humanities and inconsistent ruthlessness of mankind, and such the little wings that waken, or for the moment call into action, the dormant charities of

your soul. May these hereafter find a larger scope, worthier objects, and less interrupted success!

Help ever the helpless, be it a drowning fly, or a brother floundering through the difficulties of life's first tasks; and down the long vista of life I see you, with little wings and slender strength, it may be, for it needs not vastness of resources or extent of power to minister such heart help as the true-hearted can render.

I see you the friend of the friendless, the ungrateful and ungracious; the raiser of the fallen, though, perchance, only perversely to fall again; the cheerer of the cheerless, though it may be they droop again when your bright presence has passed away: but evermore, a little thing, perhaps, in all that men deem great, on little wings of small assistance, bearing little souls—and ever on that track yourself—heavenward, upward, and may it be to heaven itself, where true greatness and true littleness are mirrored in their real proportions. Yes, draw them upward, win them from the slough of despond; bring them, as best you may, to the sunshine of better days, and see to it that heart and strength revive for efforts in the right direction, which to men, as to flies, are the only safeguards against the poisoned footfalls that await the weak and unwary.

And what the return? Perhaps nought. In helping your helpless fellow-man, woman, or child, you may meet with that rarest of graceful things, a grateful heart, while yet expecting not; you act out the energies of a loving nature, as in saving the fly you simply

gratify a benevolent instinct, for, in truth, no one *loves* a fly, nor may we suppose that, speaking in the language of men, and especially of women, that the fly has a *heart* at all.

In aërial nature they are the great untaught, unwashed, destitute of the constructive, imitative, or ornamental faculties for which other winged things are noted. They congregate in myriads, when they please, *where* they please; or, if they please, they walk alone, defying our

THE BLOW-FLY.
Natural size.

THE MOSQUITO.
Magnified.

THE TZETZE.

centres of gravity by a promenade feet upwards on the ceiling, or up and down the glittering surface of the window pane, pursuing objects invisible to us, following behests unknown to all besides, and apparently responsible to no authority for the fulfilment of any of their duties in life.

To torment in various modes and degrees, from the gentle titillation of the bluebottle—who presumes to take his exercise on your cheek—to the maddening irritation caused by the fatal bite of the tropical Tzetze, appears to be a law of their nature; they seem to be creatures eminently unwelcome, and of whom in general a good riddance is the *summum bonum* of our wishes.

They are, in fact, very *negative* characters, and, like many human beings of whom we are apt to think that their room is better to have than their company, we have little idea what they save us from; these *city* Arabs of the air, street-sweepers of the invisible atmosphere, scavengers of ethereal poisons.

Cause and *effect* are so blundered over in all our hasty notions about things in general, that we can be in no way surprised if a strange jumble should often exist also in our judgments as to *cause* and *cure*, and if we should sometimes blame for the very evils he removes the unfortunate insect whose advent portends corruption, and especially our old friend the bluebottle, if in his efforts to withdraw from use that food which is becoming unfit for man, he calls to his aid the fecundity of his nature, and takes possession of our viands after a fashion peculiar to himself, and which we decline to dispute with him. The evil so abhorrent to our feelings can only be laid at his door, in a sense which involves its speedy removal, and the conferring on ourselves a very real though a negative blessing.

Treated much in the same manner as the pariah dogs of the East, these and other flies are yet in their myriad winged activities no less the scavengers of the air than those despised quadrupeds are of the earth, and happy may it be for ourselves that we see not the reverse of the picture at which we rail, nor find ourselves in some sad hour, when the spider proves too many for the fly, surrounded by the odours, the miasma, and

the pestilences from which the presence of the fly relieves us.

We have heard of vast clouds of flies attending on the course taken by certain epidemics; and hence, say some, the flies have brought the fever, the cholera, &c., &c. Nay, truly, camp-followers they are, on these fierce invaders, not predatory hordes themselves, gathering out from the air all that could offend, relieving the earth from many of the death-inviting miasmas which haunt its surface and prowl around the dwellings of careless men, inviting evermore the exterminating breath of the invader, and hatching a camp for the dwelling of disease.

Though to make friends with a fly were a vain attempt, we may yet bring it to terms of very close acquaintance, and, under the friendly light of the microscope, discover that it is, in its anatomy, one of the most interesting objects of scientific research, and in such close analogy to the larger animals, that a similarity, amounting almost to identity, has been discovered between the foot of a fly and the hoof of the rhinoceros. Adapted, doubtless, both these members are to the behests of their owners, though so different; the one being suited for the slow terrestrial locomotion of a heavy beast, the other to rambles in an inverted position on the ceiling above our heads, where, under the aspect of antics and evolutions of the oddest description, it is engaged in the consumption and carrying away of many a fly-load of accretions on those surfaces which have met the ascending vapours of many noxious things.

The scavenger life of a fly in that phase of its existence is yet a very short, though, by us, the most observed, period of its existence. We call them torments, crush them, poison them, set traps for them, and exult in their destruction, and then save the stragglers one by one, just when, in old age, they come to claim our hospitality, and a shelter from the chill winds of autumn, having deposited their eggs in the old crannies whence erst they crawled themselves, and spent their early days among the fruit and flowers, or (if they were bluebottles) among the

LARVA OF HOUSE-FLY.
Magnified one-half.

HOUSE-FLY.
Magnified one-half.

animal decays which nourished their youth. The changes they have undergone are not less curious than those which attend the more interesting creatures whom we watch, as caterpillars, cocoons, or moths—yet unobserved, save by the most ardent students of nature, let them, say we, remain; over the early life of a fly let us draw a veil.

A busy, active, and indeed useful life, it is, like that of all scavengers, from the pariah dog to the crossing-sweeper, and with much more to laugh and grow

fat upon than the latter, poor fellow, ever enjoys; yet its diet is uninviting, its form repulsive, we shudder to think of it, we name it not. Like some of the more despised yet useful members of the human family, they far outnumber the more attractive individuals, and that they are designed to fulfil no insignificant part in nature may be gathered from the fact that from one mother not less than twenty thousand living sons and daughters are known to have descended.

Between the early life of the fly in this caterpillar form and its subsequent aërial existence there seems to be less connection than between the earlier and later life of any other insect.

There is not one point of resemblance either in outward form or in inward structure between the white, soft, pulpy, eyeless and legless body which has twisted and wriggled through its blind career, and the restless, buzzing tormentor which dances merrily in the sunshine. The one does not seem to grow out of the other, but to be suddenly transformed, when the little creature leaps forth to its new life. Its white skin becomes dark-coloured and hard as soon as it has reached its full size, and forms a case within which the unseen change goes rapidly on.

If we counted the rings of which we observe the larva is composed, we should find that they are always seventeen in number. Now these rings or segments each go to make up some part of the perfect insect, but not always in the same order in which they are now arranged.

In fact the fly, in becoming one, turns itself partly inside out, after the fashion of the clever snake which the showman said could swallow himself, beginning by putting his tail into his mouth. The first three rings form the mouth, this important member taking up its fair share of the whole; the next two form the antennæ or feelers by which the fly exercises the sense of smell, and the eyes; the sixth, seventh, and eighth form the thorax or throat, by which it breathes, and to which are attached the wings and the three pair of legs; while the nine last form that most important part of the body, the stomach.

But in the fly, while the mouth is formed from the first segments, the head is formed from the rings behind from the fourth to the eighth. The brain (for the fly really has a brain) is the only part that remains the same in substance though quite changed in form, while all the other parts of the new animal grow round it.

As soon as the perfect insect is ready to come forth it splits the old dried shell in front, doubles itself up, and so cracks it along its whole length below, when it sallies forth with very stunted wings, which in a few minutes, while the newly-exposed skin is becoming dry, quickly grow, until after a little flapping and fanning the fly finds it can mount into air, and starts on its new life.

ABOUT FLIES.

PART II.

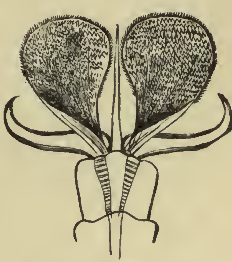
AND now, if we proceed to examine the transformed fly, we shall find wonders in its construction equal to any of those revealed to us in the anatomy of the largest and most complex quadrupeds.

We have often seen a fly walking upon the ceiling or running up a smooth pane of glass, and we may have wondered how it managed not only to hold on, but to run about so nimbly. An examination of that wonderful machine, a fly's foot, by a powerful microscope, will explain the whole of the very simple contrivance by which it seems to set the laws of gravitation at defiance.

There have been several clever guesses. Some have fancied that the hairs on its foot could take advantage of the slightest irregularity of surface; others that the foot was furnished with a natural air-pump by which the air in its hollow was exhausted, and that it thus clung like a

cupping-glass when applied to the flesh by the pressure of the atmosphere outside.

Now, if with a microscope we examine the foot, we shall find it to be composed of a pair of pads with a pair of hooks above them, and the pads clothed with a number of very fine short hairs. Each pad is hollow, with a little nipple projecting into it. Behind the nipple is a bag connected with it, filled with a very clear, transparent gum. This gum, which is quite liquid, exudes from the nipple by the pressure of the insect in walking, and fills the hollow. The hairs are also hollow, with trumpet-shaped mouths; and these are also thus filled with the gum. This gum becomes hard the moment it is exposed to the air, and will not dissolve in water. Thus, at every step, the fly glues itself to the surface; and so tenacious is the gum that one foot is quite sufficient to bear the weight of the whole suspended body. If we examine the footprints of a fly on a window-pane by a powerful magnifier, we shall find that each footmark consists of rows of dots corresponding to the hairs on the footpads; in fact, the footprint is merely the traces of the gum that have been left behind.



UNDERSIDE OF FOOT OF BLOW-FLY.

But how is it that the fly is not glued for life to the spot at the very first step it takes?

Doubtless it might be so, if it tried to lift up its foot directly in a perpendicular direction; but it draws it up gently in a slanting direction, detaching the hairs in single rows, just as we might remove a moist postage-stamp by beginning at one corner and gently drawing it back. When, however, the insect is diseased, the gum is very apt to harden, and at its death it at once becomes solid.

Thus we may often see a dead fly firmly attached to the wall, or to a window-pane with a dull-coloured mark on the glass. This is caused by the fluid having glued the weak or sickly insect to its last resting-place, and having then hardened, the fly is cemented to the spot, till it decays away, leaving the legs behind. So very small are these trumpet-shaped hairs, that there are more than 1,000 on each footpad. We may add that moths, beetles, and all other insects have the same kind of gum secreted under their footpads.

Not less wonderful is the brain, or rather that which stands for it in the fly.

Yet whilst we have spoken of the brain of a fly, it must not be thought that insects have brains like the higher animals. In all these there is a large mass of brain protected by the skull, from which the spinal cord or marrow, which is a sort of continuation of the brain, extends to the extremity of the backbone. Insects have nothing like this, though they have what answers the same purpose in their organization. They have what are called *ganglions*, or large clusters of nerves, from which

fine threads run in different directions. But instead of their being collected into one centre, there are different groups of them in different parts of the body: those of the head supplying the different organs of sense, the mouth, the eyes, and the antennæ by which they smell; those of the thorax or middle section of the insect supplying the place of the heart, and being the nerve-centre of animal life; while another set supply the stomach.

From this separation it happens that the life of an insect chiefly depends on the thorax or middle part. If this is crushed, the fly is instantly killed, and there is not the slightest motion afterwards. But if the head be cut off, while this ceases to move or to show any sensibility, the body will move for hours. If breathed upon or touched with a needle, there will be an attempt to run or fly; if dust or water be dropped either on the legs or abdomen, the feet will at once begin to rub it off. This seems to prove that these movements of the insect are at all times not the result of intelligence, but simply involuntary natural actions.

HEAD OF HOUSE-FLY (Magnified).

But yet there may be some intelligence even in a fly. Its substitutes for a brain, called the *cephalic ganglia*, are far larger than those of any other insect except the bees and ants, and are thirty times larger than the correspond-

ing organs in a beetle of the same size. In bees, wasps, ants, and flies have been discovered what have not yet been found in other insects, a pair of nerve-centres on the top of the cephalic (or head) ganglia, which anatomists suppose to answer to the brain lobes in higher animals.

Perhaps this is the reason why the fly seems to show some intelligence, at least memory, in avoiding any one who has been chasing it. At any rate from these centres proceed the nerves which run to its lips and enable it to taste, and to its eyes and antennæ and enable it to see and smell. All the senses are very highly developed in insects, more so than in higher creatures; and this renders it the more probable that their acts are for the most part caused by impressions from without, just as we shut our eyes when anything approaches them, or suddenly withdraw our hands from a burning substance.

Of all the organs of sense in the fly, the eye is the one most like the corresponding organ in other animals, and it is far more powerful than in any of them. To see as well as the fly, which can observe everything in four-fifths of the circle round it, we should require two more pair of eyes, in the side and at the back of our head. In the fly, no two facets or eye-discs look towards the same spot; and we must remember that the insect's eye is not a simple eye, but a vast collection of eyes in one head looking in all directions at the same time. There are between 4,000 and 5,000 of these little lenses, each

of them a thousandth part of an inch in diameter, and set in a six-sided flat frame; and behind every facet or lens is a transparent cone with a nerve from its point to the ganglion or brain.

We cannot be quite sure that flies smell by means of their antennæ; but if they are cut off the insect seems quite helpless; and from its uses of these feelers it seems likely they are the organs of this sense. That they can hear we may conclude from their power of emitting sounds, and from the way in which they will disappear if one of their companions is caught and makes the sharp piteous drumming cry they send forth when in pain or fright.

But no one has yet discerned the outward ear or organ of hearing in this insect, though it has been believed that their ears are just behind their wings, in the thorax instead of the head. These are what are called the *halteres*, and are in the place where the second pair of wings are fixed in bees, ants, and other hymenopterous insects.

We might go on page after page to describe the wonderful anatomy of the fly, as the microscope has revealed it to us. In fact, there is as much to be said about it as about the body of man, and perhaps more, for its organs are more numerous and more complex. Not only has it 4,000 eyes instead of two; three sets of brain or nerve-centres instead of one; 1,000 hairs and two claws instead of toes on its foot; it has also wings, which we have not; three pairs of legs instead of one;

a mouth which would bewilder any dentist ; and a proboscis as far beyond that of an elephant in complexity of structure as a railway engine is beyond a wheelbarrow. But we hope we have said enough to excite your curiosity and your admiration of the works of God,

A PLAGUE OF FLIES IN THE TROPICS.

which are as perfect and sublime in the tiniest thing that creeps as in the great worlds that whirl through space.

Of one thing we may be quite sure, that even flies were not made for nothing, and that a great many much larger beings would do very badly without them. They

are often very troublesome, they may be and have indeed been plagues, and certainly in many hot countries they are great plagues at some times of the year. But it is just when they are the greatest plagues that they at the same time are most useful. Of course, if every fly mother reared 20,000 offsprings, and every daughter of hers reared as many, there would soon be no room for anything else in the world but flies, and then the flies must die out of starvation. But it is not so intended.

Living and dying, the fly has its uses. Dying, it supplies the food not only of the spiders, who must live like other things, and would fare badly if no incautious fly glued its feet in their web, but it is the direct support and dependence of thousands of our special favourites.

How dull would be our lanes and fields without swallows and martins skimming over them, or our hedgerows without the little song-birds which come back with the spring to refresh themselves and rear their young in our northern home, after a winter's sojourn in the deserts or forests or marshes of Africa! Yet these feed almost entirely on flies. The swallow, whose appetite is as large as its mouth, needs myriads for its sustenance, and darts through the air for hours without a pause, snapping up the flies in its course.

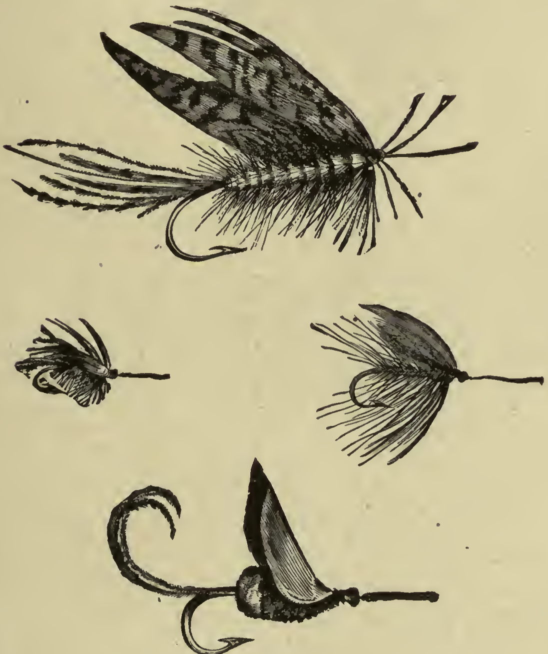
The little willow-wren darts up into the air, and as it hovers, snap, snap goes its beak, while one fly after another is secured, till the swarm that buzzed over the hedgerow is scattered, and the little sportsman alights again, till very soon the incautious cloud is dancing

over the fatal spot again, and invites him from his retreat to collect another savoury mouthful.

The pretty graceful fly-catcher of our gardens adopts a more dignified mode, and sits motionless on its perch at the end of a branch, or on the top of a peastick, its keen eye keeping an eager watch, till it sees an unsuspicious fly approach, when with a dart it shoots forth and seizes him, but always returns to its perch to swallow each morsel, as though it disdained to gobble up its food without due consideration.

Chameleons, and many other of the innumerable lizards that swarm in all hot countries, secure an ample sustenance with even less exertion than this, for they sit contentedly on a bough, and only shoot out their gummy tongue at the fly that buzzes near them. The toad, too, is fain to content himself with what he can catch on the tip of his tongue. But as he is not fond of bright sunny situations, it is well for him that his appetite is not very voracious, for he has to practise as much patience as an angler, before he can induce a curious, incautious fly to come and examine his nose. Wasps, too, feed largely on flies, as we may see by the heaps of flies' wings strewn round a wasps' nest. And if the trout had not discovered what a savoury morsel is the fly that dances on the stream, what a very dull, stupid amusement would fishing be! There would never have been the ingenuity which humbugs the fish by covering the hook with the feathers so neatly fastened together, to imitate the living fly, and the skill that makes the little cheat dance so lively on the

water, that the trout must come to look at it, and is very soon safely landed on the grassy bank. How many a schoolboy would lose the greatest treat of a summer's



ARTIFICIAL FLIES FOR FISHING.

holiday, if there were no flies, and no trout that appreciated them!

If it were not for the bluebottle and other flies whose larvæ feed on decaying flesh, the carcases of animals

might often create pestilence and disease. There are other flies whose larvæ are equally partial to decaying vegetable refuse. In fact, every substance that ought to be out of the way, and is a nuisance, is the object of the fly's research ; and soon can they clear them off. They will make skeletons of a mouse or a little bird, very cleanly picked out for the student of anatomy, in a very few days.

But this habit of searching out and feeding on putrid matter causes one of the most serious injuries of which the fly is guilty in hot climates. Its taste or smell leads it to settle on any sore and to feed on it. This would be all very well, but, unhappily for many, the fly, as we have seen, has a very gummy foot. One of the most common diseases in Egypt and other Oriental countries is ophthalmia, or running sores of the eyes, which often produce blindness. This complaint is highly contagious, but only by inoculation. If it were not for the flies, there would not be much danger in this, as people are not in the habit of kissing with their eyelids. But the fly perseveringly attacks the sufferer, and perches on the moist eyelid. Soon chased away, off he goes, and if with his wet feet he makes his next settlement on the eyelid of a healthy person, which too often happens, the result is certain to be an attack of ophthalmia. This is a kind of infection which no care or cleanliness can obviate.

ABOUT FLIES.

PART III.

THERE are other flies, very nearly akin to the house fly and the bluebottle, of which it is very hard to discover the use, excepting it be to act as scourges to man and beast.

Who can ever say a good word for that thirsty little blood-sucker, the mosquito, as the small gnat is called, which murders sleep in Lapland and Labrador as much as in India or South America? Happily in England we know very little about them, excepting from the painful recollections of travellers. There is only one safeguard against them, and that is to be miles away from any water, for water is indispensable to the early life of the mosquito.

The female lays her eggs close together in the shape of a boat, on the edge of some leaf or substance floating on the water. The little raft sails away, and in

two or three days the eggs are hatched, and the larvæ swarm by millions in every pool and stagnant ditch, and even in water jugs or basins that have been allowed to stand a day or two. Like the larvæ of flies, they have no legs, and when not disturbed float on the top of the water with their heads downwards, for they breathe air through the ends of their tails, which are shaped like a funnel.

If the water is in the least degree disturbed, they dive or swim most rapidly, but they feed only while motionless. They do this by means of a circular fringe of hair round the mouth: the little creatures twirl these hairs about, so as to cause tiny currents, which bring microscopic substances within their reach, which are thus drawn in.

In another week or two the larva moults, and in a few days, a second and then a third time, splitting up its old skin, and coming out with a fresh dress, when it changes to its third state, like the chrysalis of a butterfly, only that it still moves about, sometimes at the top, sometimes at the bottom of the water, but never eats. In eight or ten days more it comes to the surface, lies on its back, and after a few struggles splits its hard skin into the shape of a boat, in which it sits. It raises its head and then its body, till it stands upright like a mast in the floating boat; then it gets its feet clear of their shell; and when it has freed its third and hindmost pair of feet, it leans to one side, rests its fore-feet on the water, waits a few instants, while its body, which was

TRANSFORMATIONS OF THE GNAT.

quite white at first, becomes first greenish and then black with white rings; it unfolds, fans, and dries its wings, which were snugly folded very close within its old skin; and then off it darts, to disport for a day or two in the air, and, unless picked off by some passing swallow, to torment any human or other beings within reach.

It would be some excuse for these blood-thirsty little creatures, if it were a necessity of their existence to draw the blood of the giants they torment; but there are millions of them who lead innocent and happy lives, without ever having used their proboscis. It is only a bad habit, a mischievous luxury, in which they indulge when they have a chance. When they do find a victim, nothing but leather will keep them out; and besides their sting, their sharp stridulous note is so tormenting, that many sufferers find it worse than their bite. Their proboscis is a sort of hollow pipe, with a very sharp point; this tube they thrust into the skin, and as soon as it has penetrated to the veins, they shoot down through it several lancets with barbed points, notched like a saw, and then suck up the blood from the wounds. Not content with this, they eject a powerful acid at the same time, which causes swellings and intolerable irritation—sometimes for several days—and often serious sores.

Sometimes they have appeared in such numbers, that their clouds at a distance looked like volumes of smoke rising from a fire.

We are told by historians that Sapor, the King of

Persia, was once compelled by them to raise the siege of a city, and that not only his soldiers were attacked, but his elephants and beasts of burden, till they became perfectly maddened and unmanageable. In some parts of South America the inhabitants have been compelled to sleep on the ground, buried in the sand, with only their heads out, and these covered with handkerchiefs to secure rest This was both witnessed and experienced by Humboldt.

The traveller, Dr. Clarke, tells us, that once in the Crimea he was attacked by a swarm at night, when not

GADFLY.

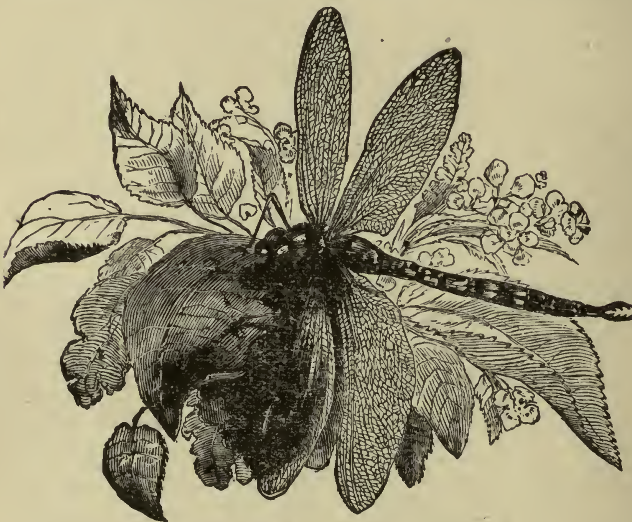
a breath of air was stirring. Driven from his quarters, he vainly took to the carriage outside for refuge. Almost suffocated with heat, he dared not venture to open the windows; still the torturing little creatures contrived to find their way in. He wrapped his head in a handkerchief in vain; they filled his mouth, nostrils, and ears. At length he succeeded in lighting a lamp, but it was extinguished in a moment by such a prodigious number of mosquitoes, that their carcases choked up the glass chimney, and formed a heap over the burner.

There is another fly which is, if possible, a yet greater tormentor of cattle than the mosquito is of man—the gadfly. When its tormenting buzz is recognised, we may see a whole herd of cattle rushing wildly about, with tails outstretched, in abject terror. The gadfly is far worse than the gnat, for it actually buries its eggs in the skin of the animal, and leaves them there to hatch, when they live upon the flesh for days, and often destroy the poor animal by the sores they create. The most terrible of the gadflies is the Tzetze of Abyssinia and other parts of Eastern Africa. It sometimes renders whole districts desolate for miles, by destroying all the animals, and thus reducing the poor inhabitants to a state of starvation; and Dr. Livingstone tells us of regions where for a part of the year no one is able either to live or travel, until the wet season destroys these terrific scourges.

This is indeed the dark side of fly-life, so far as we are concerned; but we need not close our connection with flydom with such doubtful characters. There are members of the vast and illustrious kingdom of flies whose origin is not a whit less wonderful than the wonderful origin of the gnat and mosquito, and against whose respectfulness of behaviour to the human-kind at least there can be brought not a single charge, who also add to all the wonders of origin a beauty of being which stands almost alone.

Dragon-flies, darting from reed to reed along the margin of brooks, bathed in the heat and light of a July

day, are amongst the most graceful and splendid of living things. By the French, for their elegance of colour, form, and motion, they are ranked as the "young ladies" of the insect world. These flies are always large, their bodies are of a brilliant metallic lustre, and combine all



DRAGON-FLY.

the colours of the rainbow. Their wings are extremely delicate, their substance is of a crystal clearness, covered with fine and vivid tracery. They appear to love the sunshine, but scarcely perhaps because the sunshine burnishes all their splendours. They dart about with great rapidity; they have few enemies, save and except

the silken nets and straw hats of naturalists and school-boys, and few things excite either of these classes with a desire to possess so generally and strongly as the fiery dragon-fly. But their remarkable alertness in rest and swiftness in flight generally outmatches the tact and zeal of their pursuer.

DRAGON-FLY.

Yet these fairy creatures are born in beds of mud. Their mother lays her eggs in ponds and streams. From the egg comes the baby-fly, which is called the larva, and a curious little creature the baby-fly is. It runs along the mud bottom of the water, catching insects and

tiny fishes for its baby food. For this purpose it is furnished with a curious apparatus by which it first deceives, then seizes its prey. Whilst the tiny insect is keeping, as it imagines, at a safe distance from the ravenous intruder into his domains, lo! to its astonishment and speedy destruction, off shoots the intruder's head, and leaving its place in the body, in half a wink, seizes the insect, draws it back, and devours it. No wonder, you will say, if the fish is surprised at such a feat.

But does the larva's head really come off?

No, not really; but to the fish, who has no time to examine and reflect, so it appears, for the little creature is furnished with a mask—a mask, too, with real jaws and strong joints; and this is fitted to a rod which draws out to a length equal to the whole length of its body. "This," says Charles de Geer, their historian, "they shoot forward suddenly as a flash of lightning, seize the insect between their two pincers, then, drawing back the mask, they bring the prey to their mandibles and begin to eat it."

I am sorry to hear that these baby-flies are cannibals; for, besides devouring insects and tiny fishes, they will eat one another. But in this respect the child is *not* the father of the man; for when they have past their babyhood, long before they are full-grown, when indeed they are only boys and girls, they put away this bad habit, and sin no more.

Whilst young, they show great tact in the use of their powers. When most anxious to procure food, they move

about with greatest patience and apparent satisfaction. Thus, whilst attracting no attention, putting their prey off guard, they select a victim, steal up to within a reasonable distance, then instantaneously capture. "It is very difficult," said De Geer, "for other insects to

THREE AGES OF THE DRAGON-FLY.

avoid their blows—because, walking along in the water, generally very gently, and, as it were, with measured steps, almost in the same way as a cat does on the look-out for birds, they suddenly dart forward, then mark and seize their prey."

But we must not stop too long under water, July is coming, and the larva, our dragon-fly-to-be, passed into its pupa state, climbs up one of the reeds, and hangs itself out to dry. Tired of its eleven months of water-life, it seeks the aërial life for which it was made. Shortly the drying process culminates in the cracking of its skin, and out of the crack, head first, emerges the dragon-fly. Still the drying process must be continued, for the wings are too soft, as well as too small, for flight; but sun and air soon do their work, and in a few hours after the opening of the prison doors, the perfect fly stretches its glad wings and flies away.

We have now told enough, we hope, to let our readers see that even flies have their uses, and that, whether we examine their history or their structure, they are not the least wonderful of the many wonderful things with which God has stored this prolific earth of ours.

ANTS AND ANT-HILLS

ANTS AND ANT-HILLS.

Part I.

"MOTHER! I have been to the ants, and I sat down on a little mound to consider their ways, and—and—they've—stung me!" exclaimed a youth of small dimensions rushing into the house, rubbing his arms and ankles, and trying to brush off the angry insects from his neck and ears.

"As might have been expected, with less wisdom on your part than on theirs—when you have been sitting like a huge giant on the top of their newly-built house, crushing it in, with all its long galleries and beautiful gateways, its upper and lower stories, its nurseries, cellars, and grand central hall—poor little insects! How could they think that a child who was able to destroy their work of weeks had really come to learn a lesson and to take an example from their tiny selves?"

"Yes, indeed, mother; but I did want to know about

them. Was it not enough to provoke any one? I was so vexed at being wakened up when I was sleepy; and then for nurse to be always saying the same thing, 'Go to the ant, thou sluggard!' I thought at last I would go and watch them, though I am not a sluggard, and see if they did not get a good sleep when they wanted it, without being forced to get up like me."

"And so you went, when you had been out of bed a few hours, and had had a good breakfast, to see whether the ants were as early risers as yourself! If you had been up with the sun, and could have seen the inside of that busy little ant-hill, instead of crushing it with your weight, you might have seen the careful and diligent nurses who live in the upper stories of that wonderful house very early astir, and going to call their young masters down below. You might have seen them tapping them with their little antennæ, which look like horns, as much as to say, 'Time to get up, the sun has risen;' and then waking up the little baby-ants, and carrying them up through the long galleries that lead to the top of the ant-hill; and then so carefully laying them outside that the bright rays of the sun might warm them and help them to grow, as to be an example to many human nurses who stand talking and leaving their babies in the cold."

"Now, mother, I do believe you are only inventing a fable to tease me. How can anybody tell what those little creatures do underground? And, besides, I am very sure you would be angry with nurse if she took

me and baby out in the sun, and without a parasol, too, to put over baby's head."

"I assure you the nurses of the little baby-ants are very careful not to leave them in the heat of the sun after the very early morning. As soon as the air gets warm, and the sun is hot, they carry them into the rooms near the top, where the rays have penetrated, and where the warmth can still reach them. But the older ants can bear the sun, and like to feel its rays; and though they are very industrious, yet, as they begin work with the dawn, they take a little rest sometimes in the heat of the day, and lie heaped together in the sunshine. But do not be surprised if I still tell by-and-by about some ants who do walk about with green parasols, and——"

"Stop, please, mother, do! I am sure you are only laughing at me. But I really should like to hear something true about ants. Are they like bees that make honey?"

"They make no honey, nor do they build such curious combs as we see in the beehives, but in their own way they are just as wonderful; though, as we are told, they have no guide, overseer, or ruler. I always think they are intended rather as an example to older people, who have to provide for themselves and their families with diligence, while they have health and strength, than for children, who are guided, ruled, and overseen by their parents, and have everything provided for them without any trouble of their own."

"Oh, but the little baby-ants must be just like us, because you say they have nurses too."

"Yes, in one way they are. Just so long as they cannot run alone, they are dressed like the young children in the East, or like the babes which the Indian squaw hangs behind her back or on a peg in her tent. They have natural swaddling clothes. They are wrapped up so tightly in their larva covering that no legs can be seen, only a head and wings can be traced through the transparent skin in which they are folded. Of course you know they begin life by being an egg, but they are hatched in a fortnight, and then the nurses take such care of them to keep them clean, to brush and comb and shampoo them, that very soon they begin to be ready for the next change. If you could only look at the tiny insects, the nurses, through a microscope, you would see on all their legs some very fine soft hairs, which they use as brushes, and a spur close by, which, if needful, we may imagine can do the work of a comb. The shampooing is done by working about, kneading, and distending the thin skin which covers their limbs, till it is ready to open, and let them go free. Then they wind a curtain of silk round their own little bodies, and go to sleep, to wake up full-grown ants without guide, overseer, or ruler."

"Then does every little ant do everything for itself?"

"In that respect they are the most wonderful animals you ever heard of. They do everything so exactly in order, and all together—all knowing their own business

ANTS CARRYING THEIR EGGS INTO THE SUN.

and doing it—that one would imagine they had a commanding-officer or a king to order them about every movement."

"Indeed, mother, if they can work as well without a king, as they wound without a sword, I think they are very well off without one. They look just like a regiment of soldiers."

"A regiment of officers they are, for each one understands as well as another the order of march and a soldier's duties. They never fear danger, but advance in their order of battle with the greatest firmness, the advanced guard wheeling round to the wings every five minutes to make room for others to come forward in their place. Myriads may be sometimes seen pouring forth from two rival cities, and meeting half-way between their respective habitations, equalling in numbers the armies of two mighty empires. Though they occupy only two or three square feet, yet the picture they present is that of a field of battle between contending nations of men."

"But what have they to fight with? Do they sting each other, as they stung me?"

"The ants, like men, have different kinds of weapons. But though there are many kinds of ants in foreign countries that have stings in their tails, and are called *Myrmica*, our common ants have no sting, but they have large mandibles or nippers, with which they bit you. They are called *Formica*. There are many hundreds of species both of Myrmica and Formica spread over all

the countries in the world. We have a great many kinds in England,—the black ant, brown ant, red ant, and others.

"But the way in which all our ants fight when they come to close quarters is by seizing each other with their nippers, and when they have hooked themselves on to each other, struggling till the weaker is dragged away. If another soldier comes up, he will seize his comrade, and so help him to pull away the other. They are so bitter against their enemies, that they will sooner suffer themselves to be torn in pieces than let go their hold.

"Some kinds attack others that are twice as big as themselves, trusting to their superior numbers, and going two against one. In these battles, when the strength of the two soldiers is equal, they will tug away at each other, and, each squeezing his enemy, will roll in the dust, and lie till reinforcements come up. Sometimes six or eight may be seen tugging in a chain on each side, pulling with all their might, till some more come up on one side than the other, and the weaker are dragged into captivity.

"But they have other weapons besides such force. When two ants grapple, they raise themselves on their legs, and turn their bodies up in front, squirting a venom from the extremity of their abdomen against the face of their foe. This poison is well known to chemists, and is called formic acid. Thousands of ants may be seen in battle shooting this poison at one another, which has a strong odour, and is as destructive among them as gunpowder is to us.

"This sort of battle is like crossing bayonets, but very often the army throws out skirmishers before coming to close quarters. When they see their enemies but cannot reach them, they stand up on their hind-feet, press their

AN ANT STORMING PARTY.

abdomen between their legs, and shoot simultaneously and with force some jets of their formic acid at the foe. This is exactly like the archers of old, or the musketry of modern battles. After the engagement, thousands of

dead and mangled strew the ground, but far more are led away as prisoners; for the ants are very fond of making prisoners, as you will hear soon, and all the time of the fight crowds are to be seen hurrying up with reinforcements on each side.

"They chiefly attack—after the fashion of the wicked slave-traders among men—a kind of ants called from their colour the negro-ant, and when they succeed in making them prisoners they bring home their slaves, and employ them in all menial offices; only with this exception, that the ants are always their own dairymaids. But that I will tell you about by-and-by. At present I will give you the account of those who have seen the attack and defence, and the droves of slaves being conducted to the ant-hill of the successful combatants; only telling you, to begin with, that they are also like the old Highlanders and the Border marauders, or cattle-lifters; and that these attacks are frequently made with a view of possessing a herd of the cows, on the milk of which they feed with so much delight."

ANTS AND ANT-HILLS.

PART II.

"OH tell me now about the dairy, and then about the fighting for the cows! What do you mean by that? The cows must be very tiny ones."

"You have often seen the little green insects that crawl up the stems of the rose-trees. They are called *aphides*, and these little creatures are the cows, which yield a sweet juice much delighted in by the ants, which keep their cows in all sorts of ways. There is a species of yellow ant, which does not roam much about, but lives chiefly on the milk of its herds, which it keeps underground—like the unhappy cows of some of the London dairy-men—at the bottom of its citadel; and an ant-hill is more or less rich in proportion to the number of its flocks.

"There are many other kinds of cowherd ants.

"Some take less trouble than others with their cows,

and, being active and good climbers, run themselves up the branches on which are the *aphides*, and milk them there. Others take so much pains as to make a little tunnel of earth from the foot of the tree to their nest, in which they carry home the cows underground, without being seen or disturbed by other ants.

"Others make stalls for their cattle, apart from their own nests. They build with earth round the stems of plants little houses, round within and as smooth and hard as these ingenious little plasterers can make them. These folds are of the shape of a funnel, sometimes of a ball, with a very small hole at the bottom for the ants to go in and out at. Other ants will make a little hollow ring of earth and decayed wood mixed into hard plaster round the branch of a tree on which are their *aphides*, which they carry down to this prison, and then visit them from the inside of the tree by passages through the bark without coming outside.

"Their way of milking is very curious. The body of the *aphides* or plant-lice is very soft and tender, and they have a proboscis by which they adhere to the leaf or plant. For fear of bursting them the ant strokes them and caresses them with its antennæ very gently, until the creature loosens its hold, when the ant gently carries it away. There are two horns near the tail of the *aphis*, which exude the sweet juices of the plant on which it has been feeding. The ant begins by stroking down its captive and flattering it with its antennæ or feelers, and then strikes these horns gently, when a little honey-like

drop is voluntarily exuded. This the ant takes up with the end of its feelers, and conveys to its mouth.

"But they not only capture, they actually breed their cows as well. They take the greatest care of their eggs, gather them up carefully, keep licking them and moistening them, and glue them together with a sort of gum from their own saliva, as the parent would have done if she had been free, and so they hatch generations of captives within their ant-hills. They also collect food and bring it to them, lest their cows should go dry for want of grass."

ANT MILKING AN APHIS (Magnified).

"But you said the ants kept slaves too. I should like to hear about their negroes."

"I do not wonder, for I think, of all the marvellous things that have been discovered in the ant-world, this is the most marvellous of all. But I must tell you how it was first discovered. It had puzzled many people who had gone to the ants and considered their ways, why it often happened that there were two kinds of ants—

black ones and red ones—together in the same ant-hill Huber, a great French naturalist, who made many wonderful discoveries about ants, at length discovered that one particular kind, which he called the Amazon ant, did nothing but fight, and he found also that in the nest where there were two kinds there were never any male or female ants, but only workers of the black sort. For I should tell you that just as there are three kinds of bees—the queen, who always stays at home, the drones or lazy gentlemen, and the workers who are females that never lay eggs; so it is with the ants also, only that their ladies are not queens, and there are a great many of them in one nest.

"Now the Amazon ants have mandibles or pincers, which have no teeth of curved shape like those of most other ants, but are straight, and are consequently more like spears or swords than hoes and rakes, such as the other kinds have. Their business is fighting, and they want servants both to build their houses and take care of their children. Accordingly, every evening, a little before sunset, they set out like the kidnappers in Africa against a negro village, to surprise some industrious ant-hill in the neighbourhood, which their scouts have reconnoitred and reported on. They surround the fortress, and then all rush upon it together. The few black ants that stand sentry at the entrances are soon overpowered, and the robbers rush at once to the rooms where the eggs and young ones are, seize them and carry them off, never taking any males or females. They bring them home

and hand them over to the slaves they already have of the same kind.

"These slaves have evidently got quite accustomed to their captive life and, indeed, fond of their masters, for they show great joy when prisoners are brought, and are very sad when the Amazons have failed. They run to meet them, relieve them of their precious load, take care of the young; they shampoo them, undress them, take off their swaddling clothes at the proper time, and feed them. The red children of the Amazons and the black captives are brought up together and live like brothers. Not only do the slave-ants do all the work of the nursery; they build and repair the castle, and they are sent out after the cows, and bring back the captives for their masters to milk. However, they always get their share. In fact, they keep the key of the pantry, for they open and shut all the doors of the castle and of the rooms in it every night and morning; and they will sometimes help the Amazons with whom they lived in fights against their own kind."

"But how can ants know one another? They look all exactly alike, at least all red ants do, and all black ants the same."

"That is another curious thing about the ants. Not only do ants of different kinds fight, but often ant-hills of the same species will go to war, yet the soldiers never mistake between a comrade and an enemy. Huber once kept a number of ants from one nest for four months in his house. At last some of them escaped and met some of their old companions. They were seen to make all

sorts of signs of joy, to kiss each other, stroke one another down with their feelers, take hold of each other with their mandibles, and then, after visiting their old nest together, they came out in great crowds, the escaped prisoners showing the way till they found the place where their old comrades were confined, got at it, and took the whole of them home with them."

"But surely, if all this is true, ants must be able to talk to each other, and tell their friends all they know? How can they make one another understand?"

"Well may you ask, and in fact they have such strange power of communicating information to every friend they meet, that the word antennate has been invented to express the dumb language of the ants. They are seen to touch each other in all sorts of ways by their antennæ, and it is no doubt by signals thus made, and instinctively understood by all, that they communicate. When one ant touches the antennæ of another, it instantly stops, and goes in the direction its informant wishes. But we have not yet been able to read this dumb alphabet."

"Well, I really think after this I could believe that ants carried parasols; though they seem to be always toiling, fighting, or working."

"There are a great many kinds of ants, and they all have different habits and ways of building. The parasol ants only live in South America, and make nests of a different kind of architecture from any we see here. They use leaves to thatch the domes which cover the

entrances to their underground homes. If they did not thatch these portions, they would be washed away by the heavy tropical rains, which would enter and drown the young ones.

"Accordingly, in order to provide leaves for thatch, they go out in immense hosts, select a tree to their fancy, and ascend it in long files. Each one places itself on the surface of a leaf, and with its sharp scissors-like jaws makes a nearly semi-circular incision on the upper side; it then takes the edge between its jaws, and by a sharp jerk detaches the leaf. Sometimes they let the leaf drop to the ground, when they are gathered and taken away by another relay of workers, but generally each marches off with the piece it has cut out, holding it over its body by its jaws, and as they follow file close to each other, not an ant can be seen, but the procession looks like a long line of animated leaves on the march. Sometimes a great heap may be found of circular pieces of leaf about the size of a sixpence, left on the ground away from any ant-hill. But if we wait long enough, we shall see a whole relay of workers come back to the place, and not a leaf will be left behind. When they reach their homes they cast the leaf down on the hillock, when another set of workers place it in position, fastening each leaf down with a little pellet of fine earth kneaded by themselves, and which acts like pegs to keep the leaf fixed. These ants make such enormous nests underground, that they have been known to undermine and destroy the embankment of a large reservoir.

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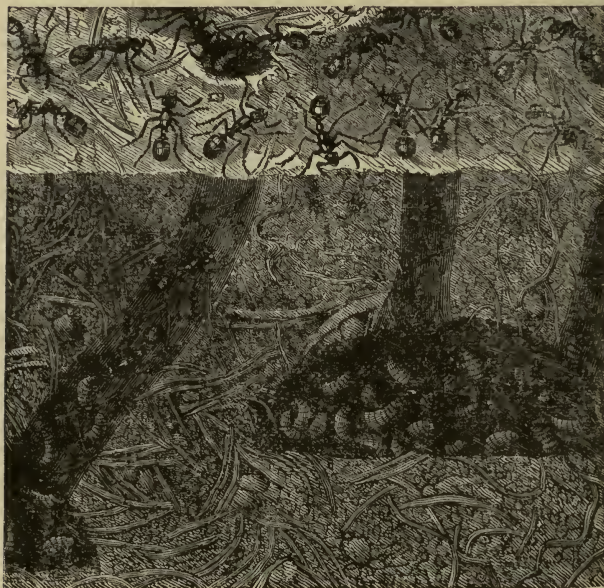
"Other ants make hillocks in the woods several feet high. Most ants in this country make the lining of their rooms and passages of blades of stubble, small fragments of wood, minute pebbles, and whatever substance they

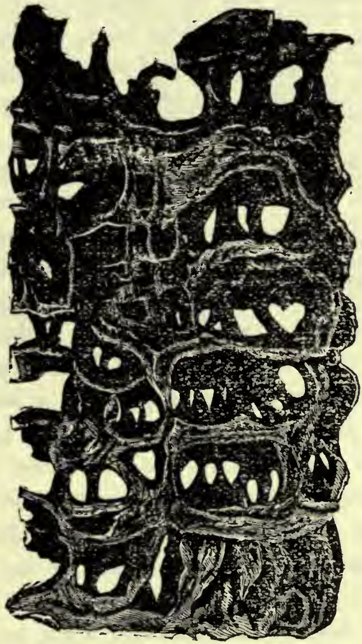


NEST OF THE GROUND-ANT.

meet with which they can-carry, and so they often pick up grains of corn. The ants which make hillocks still have the greater part of their nests underground. Some sorts make only one entrance, with long winding passages

to their halls and nurseries. Others, like our red ants, have many entrances open to the air, in the turf."

"But does not the rain get in?"



NEST OF THE CARPENTER-ANT.

"No; for they take care to have doors, and every evening, or whenever it is wet weather, they barricade themselves. They bring little beams and lay them across the gallery, then they place others on the top of them

crosswise, and finally they employ pieces of dry leaves, very broad, to cover the hole. When the last gates are shut, sentries are placed behind them, to guard and watch over the safety of the rest. At sunrise the barricades are removed, and the passages opened for the workers; but if the weather be rainy, the gates remain closed. Their earth roofs are laid upon little beams; and as they carefully knead the earth in pellets and moisten it with rain-water, and then dry it in the sun, it is exactly like brickmaking, and the sun-dried bricks turn the rain very well. Even if it should penetrate in very wet weather, the ants are pretty safe in their larger rooms which are lower down, and where they generally live.

"Other ants are called mason-ants, because they use only earth pellets or sun-dried bricks, without mixing stubble and wood, and hollow out large vaults in the ground, often many stories deep, with a labyrinth of galleries and passages. Their chisel is their teeth, their compasses are their antennæ, and their trowel their fore-feet. The larger rooms are supported by solid pillars of earth. Those different stories have their different uses. The upper ones are chiefly reserved for the *larvæ* or young, that they may be near the warmth of the sun; but when its heat becomes, as they think, too great for the little ones, they are carried down-stairs to the halls. If the rain gets in, the upper stories are still dry, and all the colony mounts to the higher chambers. There are sometimes forty stories in one nest.

"But masons, bricklayers, and thatchers are not the

only handicraftsmen among these marvellous insects. There are carpenter-ants, which hollow out the inside of trees. They will seize upon an oak or a willow, and completely scoop out many square feet without the life of the tree being at all affected. The stories and galleries are innumerable and very small, separated only by partitions left in the wood, not nearly so thick as fine cardboard, and here and there a little column standing. These supports are thickest at the top and bottom, just as in human architecture. Every pillar has a base and a capital.

"And now we may forgive the ants for all their bites, after the wonderful facts we have learnt from going to them and considering their ways."

ANTS AND ANT-HILLS.

Part III.

I THINK my readers may not object to stay a little longer, and hear one or two stories about the ants, some of which have come under my own knowledge.

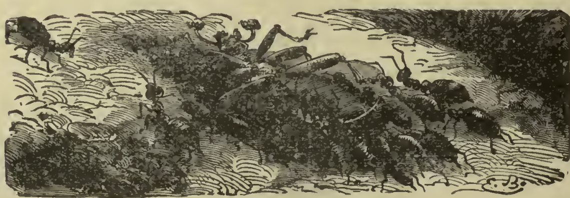
In some countries ants are very numerous. The fire-ant of Brazil, not larger than our red ants, sometimes multiplies so as to drive the people out of the villages; and when the rivers rise, or the wind blows the swarms into the water, their dead bodies may be seen washed on shore in heaps, looking like a deposit of black earth, for many miles. They undermine whole villages, and fill the houses like an Egyptian plague, disputing every fragment of food with the people, and even destroying clothes to get the starch out of them. The only way to keep anything safe is to hang it in baskets by cords from the ceiling, and to steep these cords in a very strong solution of disagreeable oil, which the ants cannot abide. To sit at

place the legs of the chair must be rubbed with this oil, and the legs of your footstool must also have been steeped in it.

In some seasons, in the island of Bermuda, there is a little red ant which is as great a plague, only that it does not bite very severely. At these times you cannot take a step anywhere without crushing hundreds of these little insects. The cedar-trees of Bermuda, a kind of juniper which grows all over the island, are covered with a sort of gum, of which the ants are very fond, and every tree is covered with long lines of them, one line marching regularly up and the next as regularly down, like files of soldiers. Sometimes I have counted more than a hundred files on the stems of a single tree. Those ants are scattered all about the rooms of the houses; but when there is nothing particular going on, you can only see an ant wandering about here and there on the floors, the wall, or the ceiling of the room. But put a plate of butter on the table; if it is not very far from the side of the room, you will see a lonely ant on the wall stop. It will turn itself in all directions, as if to calculate how to reach the plate. When it has reconnoitred for a few minutes it runs down, touching every ant it can meet on its way. Every ant that is touched passes the message to others.

Some of them you will see run across the floor and out of the room. Very soon you will see an ant climbing the leg of the table, followed by two or three more, and in less than half an hour there is a long line of hungry

insects streaming incessantly from the door, up the table, and on to the butter-dish. I have often cleared the ants away, and then put the plate on the stand which hung over the table from the ceiling. The ants would run about, look up at the dainties out of reach, make circles about as if very much confused, all touching each other with their feelers, and then on a sudden they would make a line of march down the table-leg. But they were not so easily got rid of. In a few minutes a black thread was seen rising up the wall, along the ceiling, and down



ANTS DRAGGING COCKROACH.

the cord on to the swinging stand. Happily for our dinner, this ant dislikes train-oil very much. So in the autumn each leg of the dinner-table stood in a little leaden cup of train-oil, and our chairs were likewise planted in saucers of train-oil. When we did this, our dinner was safe.

But even this troublesome little ant did us many a good turn. The most annoying pest in Bermuda was a great red cockroach, four times as large as the English one, and with a very disagreeable smell, with which it scents

everything it touches. It eats far more than the ant, and devours leather, cloth, and every sort of animal substance.

But fortunately the ants are very fond of eating cockroaches; and though it would take two hundred ants to weigh as much as one cockroach, they kill and devour thousands of them. Of course one or two ants could do nothing with it. But whenever they find a cockroach standing still, or eating, or in its hole, they collect in myriads, and without disturbing it completely surround it. On a sudden the little army rushes on its prey. The victim is instantly covered. For a few moments a struggling mass of ants is seen being moved along, but each is hard at work with its teeth, the cockroach is soon eaten alive, and nothing left but a horny skin, and the hunters are off to search for another.

In other countries, among the forests of Sweden and Switzerland, where there are very many lofty ant-hills they serve for a compass to the traveller who has lost his way by night or in the fog. Their nests are always made from east to west, with their peak at the east end, which is very steep, while the ridge slopes gently down to the nest. Thus when there is no sun to guide him, the wayfarer knows in what direction to travel by considering the ants. The Swiss also make lemonade from the yellow ants, by putting a piece of sugar into their nests, on which the insects at once squirt their acid to melt it, and it is taken out thus steeped in formic acid and tastes like lemon.

There is a story told of an ant, which reminds us of the story of Robert Bruce and the spider, and which teaches us the same lesson set forth by an ant which lived six hundred years ago. It is in the life of Tamerlane, the Tartar prince, written by an Arabian historian.

HILLS OF THE WHITE ANTS, OR TERMITES.

That terrible conqueror was once forced to take refuge from his enemies in a ruined building. As he sat alone there many hours, and was almost in despair, his attention was attracted by an ant carrying something larger than itself up a high wall. He counted the efforts it made to

gain its end, and found that sixty-nine times its burden fell to the ground, but the seventieth time it reached the top. "This sight," he said, "gave me courage at the moment, and I have never forgotten the lesson it taught me." So when we have anything to do which is difficult or troublesome, but which we ought to do, let us go to the ant, go on trying, and we shall generally succeed at last.

However, the ants can play as well as work. A famous traveller, who considered the ways of the ants in South America, says, "Their life is not all work, for I frequently saw them leisurely employed in a way that looked like recreation. When this happened, the place was always a sunny nook in the forest." He had been watching an army of ants on the march, and had noticed that while the main body carried burdens, the pioneers went before to make the road, while others with larger heads than the rest were the officers, and trotted alongside without even carrying anything. But they kept a sharp look-out, and often went out on either side to see that no enemies were lurking near. "The main column of the army and the branch columns at these times were in their ordinary relative positions; but instead of pressing forward eagerly and plundering right and left, they seemed to have been all smitten with a sudden fit of laziness. Some were walking slowly about, others were brushing their antennæ with their fore-feet; but the drollest sight was their cleaning one another. Here and there an ant was seen stretching forth first one leg and then another, to be brushed or washed by one or more

of its comrades, who performed the task by passing the limb between the jaws and the tongue, and finishing by giving the antennæ a friendly wipe."

Some ants are like drones, and never work at all. These are the male and female ants, and have wings, which none of the workers have; but they are very kindly treated, and are not turned adrift like the drones. They may often be seen in September flying about in great swarms, and tumbling to the ground together; but the female ants, which are the largest of all, as soon as they are going to lay eggs, lose their wings, which they loosen off their corselet, and then their kind nurses carry them home again to their nests. Sometimes, when they think the ladies are too fond of gadding about, they take hold of them in the nest and cut off their wings, so that they cannot escape. But they are very affectionate to them; they carry them from room to room according to the weather, bring them food, and each lady ant has about a dozen servants, who are always stroking and kissing her, and when she dies they will remain for several days brushing and licking her body before they will take her out and bury, or rather bear the body to some distance from the ant-hill.

Ants, wonderful as they are, have many enemies. There are ant-thrushes, ant-eaters, and ant-lions. Quadrupeds, birds, spiders, insects, all join in waging war upon their armies. The ant-lion, however, is not a lion, but an insect, which makes pitfalls for the ants in the sand. It chooses a place where the sand is very dry and loose, near the

ants' track. Then it scoops out a funnel with steep sides, and buries itself at the bottom. It has a large pair of jaws, which it sticks up just at the point of the funnel, but on a level with the sand, so that they cannot be seen. The ants in their travels pass the pitfalls. One of them slips on the soft sand, and comes scrambling to the bottom, as we should do in running down a gravelly hill. The moment it is there, the jaws are lifted and it is

ANT-LION.

seized and devoured, and the trap repaired for the next incautious wanderer.

I have said nothing here about the white ants, of which there are happily none in England. They are not really ants at all, but belong to another class of insects altogether, the *Neuroptera*, of which the dragon-flies are a family found in this country. The true ants belong to what are called *Hymenoptera*, and are in the same class as bees and wasps.

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ANTS AND THEIR ORGANIZATION

ANTS AND THEIR ORGANIZATION.

I MET to-day two straggling streams of workers moving along a hill-side path, one to, the other fro—black-bodied, six-legged, with a most determined aspect, and an almost forbidding look (I forgot to mention that there was a magnifying glass in my hand). Apparently each and all were much pressed for time; they hurried along singly, none speaking to his neighbour, each seeming intent on his own object, though the result was to be common; each bearing his own burden, not often helpful to others, self-concentrated, eager, bitter, obstinate, self-willed, narrow, conscientious, ambitious. I followed them till I reached a disturbed ant-hillock, which had been lately overthrown, and where the possessors were repairing their home with the most vehement industry.

Who directs them? Each seemed to be going on his own hook, minding his own business, hardly conscious of the existence of anything but himself; "frightfully in earnest," as Disraeli once said of Gladstone. Yet the

work was all in common; the community of goods, indeed, seemed absolute; no one had any personal property whatever; house, stores, eggs, everything belonged to all.

No one interfered with the rest; there was apparently no chief, overlooker, or director; yet the work went on apace, the repairing and building up of the ruined city "with neatness and dispatch."

Some seized a pellet of earth or a stone, and dragged it backwards up the steep incline, using their hind legs to cling on to rough places, while they hauled away at a weight greater far than that of their own bodies. Some hoisted aloft in their front arms, as it were, a stick or piece of grass twice or even thrice their own length, and moved forwards bearing it in the air. Each addition was placed in what each considered the best place; but the general form of the dome grew in a curiously regular diminishing curve, as if each bore the architect's elevation in his pocket. Some of the workers were making desperate efforts to move heavy (to them) beams of wood, but after superhuman exertions gave up the attempt when clearly beyond their strength. If a thing, however, was anyways within the bounds of possibility, it was wondrous with what obstinate pertinacity they would return, *e.g.* to a pellet which had rolled away from them, even to the bottom of the hillock, again and again, and begin once more to haul it up; tugging, lifting it over stones and under sticks, tumbling over with their burden on the other side of an obstacle which they had

scaled, and lying for a few seconds quite exhausted, yet never leaving hold of their burden, and setting off again undauntedly as soon as they recovered breath. Occasionally two or more were helping at a task; but they generally seemed to prefer working alone.

The ant-hill was on a steep, rocky, wooded hill-side, pink with spikes of heather, feathered with bracken, which hung over the nest, while tall mountain grasses, with bright-glazed red and amber stalks, sprang up through the moving mound of life. The August sun shone on the pleasant spot, while through the white stems of the birch I could catch sight of the river running at the bottom of the deep valley, and the sound of the dashing water among the stones far away came up with a soft murmur to my mountain perch. There was a "susurro" of wind among the trees, the twitter of the autumn note of a bird, and the buzz and hum of insect life hovered round, but the ants were all silent; and the sort of low hiss, which arose from the collected workers, resembled the noise of a London street more than any form of speech.

The rest of the world seemed wrapped in a sort of lazy content in the soft sunny weather, but the ants did not seem to be enjoying life any more than the men whom one meets hurrying along the Strand.

Probably the appreciation of a beautiful view is not facilitated by crawling over grass and sand, with one's head close to the ground! Besides, the faculty of admiring scenery is not only the distinctive quality of

man, but is confined to a very small educated section of them; and I doubt whether the ants are ever likely to be educated into lovers of the picturesque, they are too hard-headed business-like a people. I am sure they keep their account-books admirably, and have always a balance at their bankers, and that their stores are all labelled, and always to be found at once on the right shelves.

There is, however, a softer side to their characters. They are warm friends and allies, and assiduous nurses, carrying out the eggs of the community on fine days to warm and comfort the unborn children—not their own, but the nation's—and if you try to take an egg away, the guardian will be cut to pieces rather than give up his charge to the foe. He is enduring, brave, bold, enterprising; faithful to his friends, cruel to his enemies.

His muscular power is astonishing. He is said to be the strongest being of his size alive. His size may be judged by the reader who is not familiar with his form by our illustration of the ant and frog, which gives a correct idea of their relative size. And as to his mind, M. Quatrefages, an eminent French naturalist, after saying that instinct is more developed among insects than in any other creatures, adds that ants stand highest in this respect, "possessing qualities which seem to resemble those which education, perhaps, masks among men." The distinction between intelligence and instinct as shown amongst them, is difficult indeed to define. On one

213 ANTS AND DEAD FROG.

... sion he watched them dragging the wing of a cock-chafer into their nest; the opening was too small, and the workers pulled down part of the wall, some pushed at it from without, some dragged it from within, still the magnificent beam, which was probably intended to make a whole ceiling, could not be got in; they left it, increased the size of the opening, and the wing was at last swallowed up, though probably half-a-dozen interior partitions must have been thrown down before it reached its proper place; after this the door was built up again. Among monkeys, "nearest in structure to man, no fact has been observed marking deliberation and judgment in common to such a degree."

It is baffling to think how entirely we are outside such intelligent and advanced organizations as these; we cannot guess at their thoughts or feelings; their external habits even are unintelligible to us; we seem not to have a point whereat to touch. To-day they were quite unconscious of my existence; perhaps I was too big to be seen; they took no more notice of me than of a stone as long as I remained still, and if they stung me when I interrupted their business, it was my finger, not me, which they attacked. A short-sighted man, however, the other day, who approached his face too near to a nest, was spit or shot at (whatever be the engine used to eject the formic acid) for his pains, and was obliged to draw back his eyes precipitately from the sharp, stinging volley.

They understand each other, it is said, by means of

the antennæ. No doubt touch, when sufficiently cultivated even in man, is an extraordinary medium of communication, as was seen in Laura Bridgeman, the blind, deaf mute; but one would like to understand the ant's finger alphabet.

The hand in man is considered a miracle of art, but the ant seems to use his six feet indifferently, as prehensile organs, to hold, to pull, to lift, to drag, to cling. The keenness of their smell appears to be marvellous, so that not so much as a cockroach can die in the corner of a dark room but the enterprising portion of the race living in India, who eat everything and go everywhere, contrive to find it out and carry it away.

But to us the most extraordinary of their qualities is the power of self-sacrifice, the almost moral elevation whereby the good of the individual is given up to that of the community. A line of ants on their travels were once seen trying to pass a little stream, which proved too rapid for them to cross. At last they hooked themselves on each to each, and thus gradually made a chain, which was carried obliquely to the other shore by the current. Many were drowned and lost in the process, the foremost of the band were often baffled and knocked about in the rushing water, but the floating bridge was at last complete, and the rest of the army marched in safety upon the bodies of their self-sacrificing fellows. Could any so-called reasoning men have done better, or as well? Our pontoons are not made of living men.

In India, the precautions taken against their voracity

are many and ingenious, but the man is almost always baffled by the insect; wood, paper, cloth, provisions, everything but metal is consumed; even the legs of tables are hollowed out, and left standing as empty shells, which give way at a touch. In one case, some preserves had been put in a closet, isolated from the wall, with feet set in basins of water. The ants, however, were not to be so outwitted; they crawled up to the ceiling and let themselves down, each ant hanging on to the one above him, till the last link touched the goal, when a stream of hungry applicants ran down and made short work of the coveted treasure. Did those who thus profited give any of the food to the self-sacrificing members of the living chain, I wonder? And what reward did the patriot receive who held on to the ceiling and bore the weight of the rope of ants?

No wonder that the emmet has been held up as a model of wisdom and industry since men have "made morals" at all; that Solomon declares the ants to be "a people not strong, but exceeding wise," who "prepare their meat in the summer;" that Milton talks with respect of "the parsimonious emmet, provident of future,

"In small room, large heart enclosed."

But the highest praise he has received is from Mr. Darwin, who says that "the size of the brain is closely connected with higher mental powers, and the cerebral ganglia of ants is of extraordinary comparative dimen-

sions. Still cubic contents are no accurate gauge; there may be extraordinary mental activity with extremely small absolute mass of nervous matter. It seems as if the fineness of the quality was more important even than its quantity. "The wonderfully diversified instincts, mental powers, and affections of ants exist with cerebral ganglia not so large as the quarter of a small pin's head." A son of Mr. Darwin succeeded in the anatomy of an ant's brain, and his father observes, "It is one of the most marvellous atoms of matter in the world. More so even than the brain of man."

Yet such is the prodigal wealth of nature that millions on millions of these "marvellous atoms" come into the world every summer, with apparently no other end than to be eaten and crushed, and to die in a hundred different ways, after their few days of life. Their use in the world, as far as we can fathom it, is as scavengers; but, if we had been born ants, we should probably consider this a wretchedly perfunctory account of the be all and end all of our existence.

The ant may not be able to see very far, but one has a painful perception that our own vision is relatively not much less narrow.

LIFE IN A DROP OF WATER.

LIFE IN A DROP OF WATER.

CHAPTER I.

"PLANT-ANIMALS" AND "FIRST-LIFE."

DO you ask is there life in a drop of water?

Yes, indeed, there are beings born in millions, and living and dying in a dwelling so small. This is one of the startling truths which science has told us in modern times.

Without the microscope, the ancients knew nothing of its wonderful revelations—of the worlds of life, infinite in number, which occupy every spot of our earth and ocean—and doubtless, of every planet of our system, and every star that twinkles alone in the blue sky, or mingles its fading light with the milky way. Microscopes, small and great, cheap and expensive, are everywhere in use, and the humblest observer, with the smallest means, may obtain amusement and instruction, and even make

important discoveries in this new and curious department of Natural Science.

We must not expect, however, to see in a drop of water the gigantic life with which the street philosopher startles the young and the ignorant. The larvæ of dragon-flies, sometimes an inch long, and the beetles, gnats, crabs, and worms of different kinds, which are intruded into the showman's drop, are but a poor expression of the mass of life and the unrivalled organizations which the microscope reveals to us.

The name of *Infusoria* has been generally given to these living atoms, from their being found most copiously in *infusions* of animal and vegetable matter exposed to the air.

These little creatures are generally invisible to the naked eye, varying in size from the *thousandth* to the *twenty-five thousandth* part of an inch, and they are sometimes found in such a mass, that the space between each is not greater than one of themselves. They are found in every quarter of the globe, colouring the waters of lakes and pools with a scum of various colours, and sometimes forming marine deposits of great extent, and siliceous and calcareous strata, consisting of the coverings, or shells, in which they lived. Carried up into the atmosphere, these living atoms are diffused by every passing breeze over the sea and the land. They are thus raised to the tops of the highest mountains, and taken to the bottoms of the deepest mines.

Their most prolific home, however, is in lakes and ponds, to which they impart the most varied colours.

Many of them give a blood-red colour to water, others an orange or ochreous hue, others a yellow, some an intense green, and some a milky or opalescent tint. In a single day, a lake of clear water will become green. In the middle of the day, a bright sun will bring the

A DROP OF STAGNANT WATER.
Magnified eighty diameters.

infusoria to the surface, and colour the water, which will again become clear at sunset.

It is almost impossible, without numerous and accurate drawings, to give to the general reader anything like an idea of the singular forms of the microscopic world; of their structure and their transformations.

Some are oval, some spherical; others resemble various objects natural and artificial, such as different

kinds of fruit, eels, worms, serpents, crabs, and molluscæ, wheels, cylinders, bottles, funnels, &c.

Their coverings are either soft and membranous, like leeches; or hard, like horn or shell. When hard, the covering is sometimes composed wholly of silica, or flint; and sometimes of carbonate of lime, or marble. These shell-coverings consist of two or more valves, which in the bacillaria are finely grooved, and sometimes covered with spines or knobs.

When the covering is *gelatinous*, or soft, it has often the shape of a bell-glass, a cone, or a cylinder, with an opening to allow the animal to protrude. Within this case it reproduces itself, the case continuing till the covering bursts, and allows the young to escape.

The principal organs of the infusoria are hairs, or *cilia*, like those of the human eyelash. A hair of this kind forms a proboscis, which the creature uses as an oar, or paddle, to give it a progressive motion, and drag the food into its mouth. These cilia are often arranged in clusters, surrounding the mouth of the animalcule, or arranged in rows over the body. They have a rapid vibratory motion, and, in the rotatory infusoria, where they resemble toothed wheels in constant revolution, their action is one of the most extraordinary sights in the animal world. The other external organs of the infusoria are bristles, slender and thick, for supporting their body; and horns, claws, and processes or projections which they can protrude from any part of their substance.

That these creatures have a nervous system has been inferred from their possessing eyes, which have the form of red spots, from two to seven or eight in number, arranged in lines, triangles, or circles. In some of them a crystalline lens has been detected—the most important part of an organ of sight.

A STAGNANT POOL.

That these creatures require air like other forms of life is, with some exceptions, proved by many facts.

If the air is excluded from the water which contains them, either by a film of oil, or by a stopper in the bottle,

they gradually perish. They live longer in nitrogen gas than in hydrogen, or in carbonic acid gas, but they die in the vapour of sulphur.

The influence of poisons upon them is curious. When combined chemically with the water the poison destroys them instantly, but when it is only mechanically mixed with it they are not greatly affected by it. Strychnine kills them instantly, but they survive both calomel and corrosive sublimate.

The infusoria are killed by electrical, galvanic, and magnetic currents. They cannot endure a very great degree of cold. Many of them can live in a temperature of 125° of Fahrenheit, some in water raised to 200°, but they generally die at 140°, when the heat is suddenly applied.

One of the most singular properties of some of the creatures we have been examining is their phosphorescence, or faculty of emitting light, like the female glow-worm, and some species of centipedes. The light which they discharge is but a single spark, that lasts only for a second; and it is by the united light of millions that the phosphorescence of the sea is produced. Some individuals of the same species are phosphorescent, and others not.

The animals which produce the phosphorescence of the sea is an atom about the 1000th part of an inch in size. It is a viscous or gelatinous body resembling, according to Professor Huxley, a peach, one surface being a little excavated, with a groove or depression running from one side of the excavation half way to the other pole. It has

a funnel-shaped mouth, with a curved ciliary process, by which it propels itself through the water.

The animalcular bodies, whose general character and properties we have been describing, have been arranged under five groups, namely, *Phytozoa*, *Protozoa*, *Rotatoria*, *Tardigrada*, and *Bacillaria*, long words, but, as you will see, both useful and simple.

The first group is known as the PHYTOZOA, a term signifying *plant-animals*, having been considered by some naturalists as *animal-like plants;* but, whatever name we give them, they certainly stand on the borders of the animal and vegetable kingdom, "some distinctly belonging to the latter, some doubtfully to the former, while many pass through such phases of existence that at one time they assume the characters of animals, and at another those of plants."

The animalcules of this group are generally round or oval, often with a long neck, carrying the cilia by which they move. Their shape and size are strangely dependent on the light which falls upon them. In addition to the case, or covering, and the processes which give strength to the animalcule, there are two (occasionally only one) cilia, or long filaments, by which they move, acting as rudders to turn them on themselves.

The motions of some are very slow, but of others varied and lively; in some oscillating or rolling; in others, revolving or leaping. They have no mouths or stomachs, and must therefore be nourished by imbibing their nutriment through their cells.

This class of animalcule is multiplied by self-division, or fission. In the accompanying illustration (subject B), this process may be observed in all its stages.

The contents of the cell divide themselves into two or more parts, each of which can form round itself a gelatinous covering, and assume an existence of its own. Another kind of multiplication takes place, when, instead of two or more single animalcules being formed, a colony

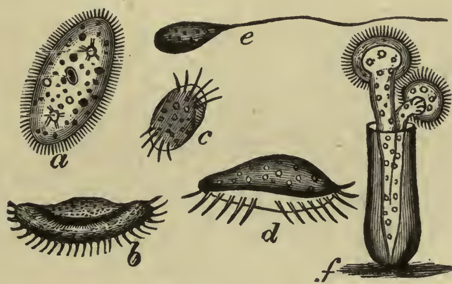
INFUSORIA.

is produced, consisting of several single cells within a common envelope. A still more remarkable reproduction takes place when the division extends beyond the third and fourth generation, until 20 or 40, or 80, or 100, or even 1000 and more, of minute cell structures are produced, in order to propagate the species by their future

Note to Illustration.—A, *Stentor*, or "Trumpet-animalcules." B, Group of *Vorticellæ : a a, Vorticellæ* in a natural and undisturbed condition : *b b, Vorticellæ* contracted in a spiral manner on their stems; a feature exhibited when the animalcules are irritated or disturbed: *c*, an individual undergoing a process of "fission" or "cleavage:" *d*, further stage of *c*, two heads being produced by the cleavage of one animalcule: *e*, one of the heads swimming away after becoming detached from the stalk. This latter will in time develope a stalk and become a perfect animalcule.

development. These little bodies hurry about or swarm within the original cell, till they are set free by its rupture, each having a spindle-shaped figure, terminated by two or four cilia.

Some of the members of this family (the *monas termo*) are the smallest of created beings—being only the 6000th, and others the 1200th part of an inch, so that they require a magnifying power of about 500 to exhibit



INFUSORIA.

their structure. They are supposed to be nothing more than the simplest stage in the existence of many animal and vegetable organisms. The monas is a round glutinous substance, and is generally colourless, though sometimes green, yellowish, and reddish. It is one of the most common organisms in infusions of animal and vegetable matter. Its organ of locomotion is a filiform proboscis near its mouth, by means of which it provides

Note to Illustration.—*a*, *Paramæcium aurelia*: *b*, *Euptotes patella*: *c*, *Aspidisca lynceus*: *d*, *Euplotes Charon*: *e*, *Peranema globulosa*: *f*, *Vaginicola crystallina*, showing the sheath into which the animalcules can retract themselves.

its food. The monas is multiplied rapidly by self-division, and does not collect into clusters.

Another family of the Phytozoa derive their name, *Volvoxinæ*, from their rolling motion, and are remarkable for the singular beauty of their forms.

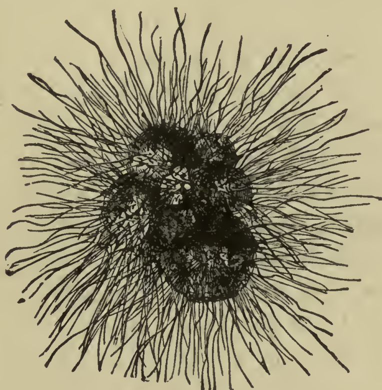
One of the most curious of these bodies consists of a hollow transparent globe, with small green spots regularly distributed. By means of cilia from these spots all the movements of the organism are produced. When the sphere bursts it discharges a number of little spheres, which gradually become like itself, their motion being visible before they have left the parent cell. When colouring matter is put into the water, strong currents are seen round each globe. The volvoxes are found in shallow pools of clear water, in spring and in summer. The largest are about the 30th, the smallest about the 360th, and a single globule about the 3600th part of an inch. Yet *Rotifers* have been found swimming about within a volvox as freely as a fish in a glass globe!

Another interesting family of the Phytozoa, *Vibrioneæ*, determine fermentations. They are found in all infusions, have neither cases nor appendages, but are linked together in threads like chains, the links being sometimes only two or three in number. The chains have a writhing motion.

The *second* group of infusorial life is called PROTOZOA, from Greek words that signify *first life*, or the simplest form of life.

Some of these have an external coat covered with

vibrating cilia, by which they swim. When this coat is hard, it is furnished with bristles, by which they crawl or leap. They have a mouth, a stomach, and many of them an opening behind. They multiply by self-division, by budding, or by internal germs. They vary in size from the 12th to the 2300th of an inch. They present a great variety of shapes, but are always round in outline. They



FORAMINIFERA—*Globigerina.*

pass through a great many phases of existence. One of these devours its own species, though nearly as large as itself, widening its mouth, and moving about with its half-swallowed food. In their motions the Ciliata often stop and reverse their course. Professor Owen thinks that their motions are not voluntary, but automatic, governed by stimuli within or without the body, and therefore motions which never tire. They always move

as actively in the night as in the day, and therefore they never sleep.

Another family of the Protozoa have no cilia, but move by false feet or shifting offshoots from their body. The animals consist of a soft, tremulous, transparent jelly or mucus, constantly changing its shape by pushing out at one or more points the processes or offshoots already mentioned. This group contains three well-marked families, all of which swallow various species of the Ciliata and Rotatoria; and within them have been found particles of sand, morsels of woollen and cotton cloth, portions of Algæ, and frustules of Diatoms.

The Amœbina, which occur both in fresh and salt water, and are found adhering to plants.

The Monothalamia, some of which are marine, and some are found in fresh water.

And the Foraminifera, which are all marine, and abound both in the living and the fossil state. As they are unable to swim, they are generally found crawling on aquatic plants, sponges, corals, and corallines. They have been found both on the surface of the sea and at depths of 12,000 feet. The soundings in the Atlantic are almost wholly composed of these animals. D'Orbigny found 3,840,000, nearly four millions of them, in an ounce of sand from the Antilles!

LIFE IN A DROP OF WATER.

CHAPTER II.

"WHEELS," "WATER-BEARS," AND "RODS."

THE *third* group of infusorial animalcules is the ROTATORIA, or ROTIFERA, a name derived from the wheel-like motion of the wreaths of cilia around their head.

These creatures have a symmetrical form, with a distinct head and body. Their figure is oblong or ovoidal, and they have a firm skin of two layers. The rotatory organ is furnished with one or two, or even three rows of cilia, by which the animal moves and captures its food, the current which they produce being directed into its mouth. They can swim onward either with or without rotation, using a muscular tail as a rudder; and they can also crawl as a leech, or leap and skip with their long caudal styles. They have a distinct stomach, and organs of secretion and sensation. Their eye-specks are commonly red. They are reproduced by eggs, and very rapidly.

According to Ehrenberg, a *Hydatina* kept in a separate vessel 101 days laid four eggs a day, and their young laid the same number when two days old. Hence he concluded, as those who work it out for themselves will find, on the twelfth day sixteen millions may be produced They multiply with such rapidity in stagnant pools as to colour the water, rendering it milky or green.

The *fourth* group of infusoria has received the name of TARDIGRADA, from the tardiness with which they move. They have been called *water-bears*, from a sort of resemblance to the bear.

They are parasitic animals, and live by sucking the fluids of others. They are found in the gutters of houses and on water-plants and mosses; and by shaking these plants in a vessel of water they will be found at the bottom. Their bodies are short and cylindrical. They produce few but large eggs, from which the embryo emerges in a perfect state. They revive after being kept dry for years.

The *fifth* group of infusorial animalcules has received the name of BACILLARIA, from the general resemblance of many of the species to a staff or rod.

This very interesting group is divided into two families, the *desmidieæ* and *diatomaceæ*, the former having a firm but elastic envelope in two segments, filled with grass-green chlorophyle, while the latter have a dense siliceous envelope, consisting of two opposite valves. The first of these families is generally considered to be plants, and the second animals.

The *Desmidieæ* have an envelope so strong as to resist considerable pressure. It is colourless, the green colouring matter, which is the same as that of plants, being confined to the interior. These bodies move slowly onwards, and have an oscillating motion, ascribed by some observers to the escape of gas. They advance towards the light, occupying the side of the vessel on which the light falls. The grass-green colouring matter is distributed in various ways, changing its appearance with age and other causes. There is a curious circulation or rotation of the fluid contents of these bodies, which is finely seen in sunlight, as produced by cilia.

This class is propagated by self-division, the process of which is very curious. One half of a frond moves from side to side, the other half being stationary, and its motion increases till it is separated by a jerk. Reproduction is effected by the coupling of two cells in two fronds. The contents of the cells are combined, and a new seed case is produced. The Desmidieæ are found in fresh water in every part of the globe. They form green masses on the surface of standing water, discharging oxygen rapidly during sunshine, and again returning to the bottom in the evening. They are the food of various small aquatic animals, and the oxygen which they discharge has been supposed to preserve the freshness of water.

Diatomaceæ have a peculiar interest, from the siliceous envelopes in which they live, and which are preserved in all their beauty after the animals themselves have perished.

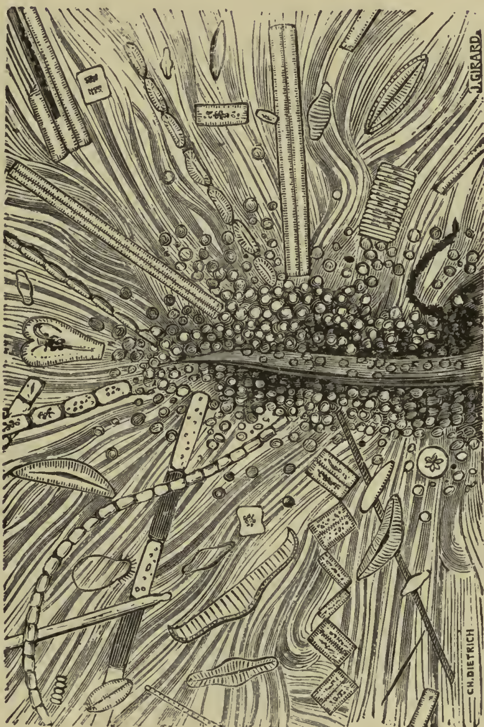
The bodies which compose this family have a great

variety of forms. They are sometimes long and narrow, like a weaver's shuttle or a boat, sometimes square, or globular, or wedge-shaped, or cylindrical like a pill-box. The frustules occur single, or attached to a stalk, or linked together in chains, or adhering in tufts. The siliceous shells have only one cavity. Neither a red heat nor the strongest acids affect these shells. The silex does not polarise light, but this arises from its extreme thinness, for a film of quartz crystal of the same thickness would not polarise light visibly. The siliceous shells are marked with fine lines or striæ, which may sometimes be resolved into rows of minute dots, and hence they are used as the finest test-objects for the microscope. Some have supposed that these markings are grooves or depressions; but Professor Bailey has made it highly probable that they are ribs, or the thickest part of the shell. The cavity of the shell contains a soft substance, with many granules and globules of a brownish colour, clustered round the nucleus or centre of the cavity.

The multiplication of the Diatoms is produced by division. The cell is cut in two; after being separated, each has an independent existence. If we suppose this process to occupy twenty-four hours, the progeny of a single Diatom would in the course of a month amount to one thousand millions of individuals.

The Diatoms live in the earth, in the ocean, and in the atmosphere, and are more widely distributed than any other organized beings. They are found in fresh, salt, and

brackish waters, in damp earth, and about the roots of plants. They are thrown into the atmosphere by vol-



DIATOMACEÆ AROUND TOP OF SUBMERGED ROSE THORN.
Magnified 150 diameters.

canoes, and are carried by the winds over the surface of the globe. They may be seen by the eye when accumu-

lated in such numbers as to colour the water. According to Dr. Hooker, they are so numerous in the newly formed ice of the whole Antarctic Ocean, as to stain the sea, as far as the eye can reach, of an ochreous colour.

Of the inconceivable multitudes of these creatures which the world contains, the following facts will be a sufficient illustration.

Their dead and decomposing bodies form the greater part of a submarine bank 400 miles long and 120 wide between the parallels of 76° and 78° of S. latitude, and the meridians of 165° E. and 160° W. longitude. They often form from one-fourth to one-third of the fine mud of rivers, such as the Thames, the Elbe, the Scheldt, and the Columbia in America, where there is a bed of clay, 500 feet thick, entirely composed of fresh-water infusoria.

The abundance of infusorial animals and other matter in the atmosphere has been placed beyond a doubt by Ehrenberg. In the showers of dust which frequently fall, and in what is called *blood rain* and *meteoric paper*, he found above a hundred different species of Diatoms. A dust shower that fell at Lyons in 1846 contained solid matter which weighed 7,200 cwt.!

When we first hear of "Life in a Drop of Water," the idea would hardly occur to us that creatures, which require a powerful microscope to show them, could be of any service to man, and still less that they performed important functions in the economy of the globe. Dr. Hooker is of opinion that on the Antarctic deposits of the Diatomaceæ the whole of the animal kingdom which

swarms in the waters of the Antarctic Ocean, perhaps, ultimately depends for its existence.

They also purify the vitiated atmosphere, as plants of a higher order do in more temperate regions. But it is not the inhabitants of the sea only that the Diatoms feed. In some parts of Lapland and Hungary, and in other parts of the world, they form an article of food in seasons of famine. In Java, an earth called *Tanah*, containing infusorial animalcules, is eaten as a delicacy by the inhabitants of Samarang and Java.

Others, again, determine fermentations, and can multiply indefinitely. They are less than the 17000th part of an inch in breadth. They have the form of small cylindrical rods, generally straight and rounded at their ends. They exist as single individuals, united in chains of two, three, or four, or even more joints. The length of the joint varies from the 17000th to the 1250th of an inch. They advance by a sliding motion, during which their bodies remain rigid, and experience slight undulations. They whirl round, and tremble actively in the anterior and posterior parts of their body. The undulations in their movements are very perceptible when the size of the animalcule is the 17000th part of an inch. They are often bent at one of their ends, and sometimes at both, a peculiarity not common at the commencement of their life. They are reproduced by the separation of the joints into young.

In every quarter of the world the Foraminiferæ form a large portion of the calcareous and tertiary rocks. They

are the principal ingredient in limestone rocks used in building, such as those which form the Pyramids of Egypt. They are abundant in the tertiary rocks of South Carolina, Charleston being built on a bed of marl 236 feet thick. "They are still at work," says Dr. Bailey, "in countless thousands on the coast, filling up harbours, forming shoals, and depositing shells, to record the present state of the seashore, as their predecessors now entombed beneath Charleston have done with regard to ancient coasts."

The geological interest of the Diatomaceæ is still greater than that of the Foraminiferæ. They are produced and accumulated with much rapidity in hot weather, and in stagnant waters. A pound of them may be collected in half an hour; and every grain of the pound contains a *hundred million* Diatoms.

An inquiry into the origin of the "life in a drop of water" has presented it in a more remarkable aspect, as connected with profound questions in physiology and natural religion. But whatever difference of opinion may exist respecting the origin of animalcular life, there is but one opinion about its universal diffusion.

In the lower atmosphere in which we live, the air is full of particles, mineral and vegetable, from substances injurious to health, and of millions of animalcules born and bred in putrid marshes, and in the countless charnel-houses of civilisation. Neither power, nor wealth, nor science, can purify the air which they poison, or strangle the scorpions which such air breeds.

The storm that changes our aërial food may leave us in a less salubrious atmosphere, and the zephyr's breath even, that wafts to us the perfumes of summer, may mingle with them the malaria through which they have passed.

The thunder-bolt from above may precipitate in meteorites the solid particles in the atmosphere; but the ascending lightning-stroke again carries them upward from the metalliferous rocks around us.

The cunning of the chemist cannot throw down the poison that twinkles in the sunbeams, or slay the vampires that swarm under our roofs.

In the meadows and on the heath, on the river-side and on the granite peak, in the day and in the night, in our food and in our drink, we cannot escape from the atoms of poison which we breathe, and the legions of swarming, crawling, and whirling life which are ever at work within and without and around.

CORAL AND CORAL BUILDERS.

CORAL AND CORAL BUILDERS.

Part I.

NOW look at this stone.

What a curious stone! Did it come from any place near here?

No. It came from near Dudley, in Staffordshire, where the soils are worlds on worlds older than they are here, though they were made in the same way as these and all other soils. But you are not listening to me.

Why, the stone is full of shells, and bits of coral; and what are these wonderful things coiled and tangled together, like the snakes in Medusa's hair in the picture? Are they snakes?

If they are, then they must be snakes who have all one head; for see, they are joined together at their larger ends; and snakes which are branched, too, which no snake ever was.

Yes. I suppose they are not snakes. And they grow out of a flower, too; and it has a stalk, jointed, too, as

plants sometimes are; and as fishes' backbones are too. Is it a petrified plant or flower?

No; though I do not deny that it looks like one. The creature most akin to it which you ever saw is a star-fish.

COMMON STAR-FISH.

What! one of the red star-fishes which one finds on the beach? Its arms are not branched.

No. But there are star-fishes with branched arms still in the sea. You know that pretty book (and learned book too), Forbes' "British Star-fishes?" You like to

look it through for the sake of the vignettes—the mermaid and her child playing in the sea.

Oh yes, and the kind bogie who is piping while the sandstars dance; and the other who is trying to pull out the star-fish which the oyster has caught.

Yes. But do you recollect the drawing of the Medusa's head, with its curling arms, branched again and again without end? Here it is. No, you shall not look at the

FEATHER STAR-FISH.

vignettes now. We must mind business. Now look at this one; the Feather-star, with arms almost like fern-fronds. And in foreign seas there are many other branched star-fish beside.

But they have no stalks?

Do not be too sure of that. This very feather-star, soon after it is born, grows a tiny stalk, by which it holds on to corallines and sea-weeds; and it is not till afterwards that it breaks loose from that stalk, and swims

away freely into the wide water. And in foreign seas there are several star-fish still who grow on stalks all their lives, as this fossil one did.

How strange that a live animal should grow on a stalk, like a flower!

A STALKED STAR-FISH.

Not quite like a flower. A flower has roots, by which it feeds in the soil. These things grow more like sea-weeds, which have no roots, but only hold on to the rock by the foot of the stalk, as a ship holds on by her anchor. But as for its being strange that live animals should grow on stalks, if it be strange it is common

enough, like many far stranger things. For under the water are millions on millions of creatures, spreading for miles on miles, building up at last great reefs of rocks,

CORAL AND CORALLINES.

and whole islands, which all grow rooted first to the rock, like sea-weeds ; and what is more, they grow, most of them, from one common root, branching again and

again, and every branchlet bearing hundreds of living creatures, so that the whole creature is at once one creature and many creatures. Do you not understand me?

No.

Then fancy to yourself a bush like that hawthorn bush, with numberless blossoms, and every blossom on that bush a separate living thing, with its own mouth, and arms, and stomach, budding and growing fresh live

COMMON SEA-ANEMONE.

branches and fresh live flowers, as fast as the old ones die; and then you will see better what I mean.

How wonderful!

Yes; but not more wonderful than your finger, for it, too, is made up of numberless living things.

My finger made of living things?

What else can it be? When you cut your finger, does not the place heal?

Of course.

And what is healing but growing again? And how

could the atoms of your finger grow, and make fresh skin, if they were not each of them alive? There, I will not puzzle you with too much at once; you will know more about all that some day. Only remember now that there is nothing wonderful in the world outside you but has its counterpart of something just as wonderful, and perhaps more wonderful, inside you. Man is the microcosm, the little world, said the philosophers of old; and philosophers nowadays are beginning to see that their old guess is actual fact, and true.

But what are these curious sea-creatures called, which are animals, yet grow like plants?

They have more names than I can tell you, or you remember. Those which helped to make this bit of stone are called coral-insects; but they are not really insects, and are no more like insects than you are. Coral-polypes is the best name for them, because they have arms round their mouths, something like a cuttle-fish, which the ancients called Polypus. But the animal which you have seen likest to most of them is a sea-anemone.

Look now at this piece of fresh coral—for coral it is, though not like the coral which your sister wears in her necklace. You see it is full of pipes; in each of those pipes has lived what we will call, for the time being, a tiny sea-anemone, joined on to his brothers by some sort of flesh and skin; and all of them together have built up, out of the lime in the sea-water, this common house, or rather town, of lime.

But is it not strange and wonderful?

Of course it is: but so is everything when you begin to look into it; and if I were to go on, and tell you what

MEDUSA SEA-ANEMONE.

sort of young ones these coral-polypes have, and what becomes of them, you would hear such wonders, that you would be ready to suspect that I was inventing nonsense, or talking in my dreams. But all that belongs

to Nature's deepest book of all, which is called the Book of KIND; the book which children cannot understand, and in which only the very wisest men are able to spell out a few words, not knowing, and of course not daring to guess, what wonder may come next.

Now we will go back to our stone, and talk about how it was made, and how the stalked star-fish, which you mistook for a flower, ever got into the stone.

Then do you think me silly for fancying that a fossil star-fish was a flower?

I should be silly if I did. There is no silliness in not knowing what you cannot know. You can only guess about new things, which you have never seen before, by comparing them with old things, which you have seen before; and you had seen flowers, and snakes, and fishes' backbones, and made a very fair guess from them. After all, some of these stalked star-fish are so like flowers, lilies especially, that they are called Encrinites; and the whole family is called Crinoids, or lily-like creatures, from the Greek word *krinon*, a lily: and as for corals and corallines, learned men, in spite of all their care and shrewdness, made mistake after mistake about them, which they had to correct again and again, till now, I trust, they have got at something very like the truth. No, I shall only call you silly if you do what some little boys are apt to do—call other boys, and, still worse, servants or poor people, silly for not knowing what they cannot know.

But are not poor people often very silly about animals

and plants? The boys at the village school say that slow worms are poisonous; is not that silly?

Not at all. They know that adders bite, and so they think that slow-worms bite too. They are wrong; and they must be told that they are wrong, and scolded if they kill a slow-worm. But silly they are not.

But is it not silly to fancy that swallows sleep all the winter at the bottom of the pond?

I do not think so. The boys cannot know where the swallows go; and if you told them—what is true—that the swallows find their way every autumn through France, through Spain, over the Straits of Gibraltar, into Morocco, and some, I believe, over the great desert of Zahara into Negroland: and if you told them—what is true also—that the young swallows actually find their way into Africa without having been along the road before; because the old swallows go south a week or two first, and leave the young ones to guess out the way for themselves:—if you told them that, then they would have a right to say, "Do you expect us to believe that? That is much more wonderful than that the swallows should sleep in the pond."

But is it?

Yes, to them. They know that bats, and dormice, and other things sleep all the winter: so why should not swallows sleep? They see the swallows about the water, and often dipping almost into it. They know that fishes live under water, and that many insects—like May-flies and caddis-flies and water-beetles—live sometimes in the

water, sometimes in the open air; and they cannot know —you do not know—what it is which prevents a bird's living under water. So their guess is really a very fair one; no more silly than that of the savages, who, when they first saw the white men's ships, with their huge sails, fancied they were enormous sea-birds; and when they heard the cannons fire, said that the ships spoke in thunder and lightning. Their guess was wrong, but not silly; for it was the best guess they could make.

But I do know of one old woman who was silly. She was a boy's nurse, and she gave the boy a thing which she said was one of the snakes which St. Hilda turned into stone; and told him that they found plenty of them at Whitby, where she was born, all coiled up; but what was very odd, their heads had always been broken off. And when he took it to his father, he told him it was only a fossil shell—an ammonite. And he went back, and laughed at his nurse, and teased her till she was quite angry.

Then he was very lucky that she did not box his ears, for that was what he deserved. I dare say that, though his nurse had never heard of ammonites, she was a wise old dame enough, and knew a hundred things which he did not know, and which were far more important than Ammonites, even to him.

How?

Because if she had not known how to nurse him well, he would perhaps have never grown up alive and strong. And if she had not known how to make him obey

and speak the truth, he might have grown up a naughty boy.

But was she not silly?

No. She only believed what the Whitby folk, I understand, have some of them believed for many hundred years. And no one can be blamed for thinking as his forefathers did, unless he has cause to know better.

Surely she might have known better.

How? What reason could she have to believe the

AN AMMONITE.

ammonite was a shell? It is not the least like cockles, or whelks, or any shell she ever saw.

What reason either could she have to guess that Whitby cliff had once been coral-mud at the bottom of the sea? No more reason, my dear child, than you would have to guess that this stòne had been coral-mud likewise, if I did not teach you so,—or rather, try to make you teach yourself so.

No. I say it again. If you wish to learn I will only teach you on condition that you do not laugh at, or

despise, those good and honest and able people who do not know or care about these things, because they have other things to think of: like old John out there ploughing. He would not believe you—he would hardly believe me—if we told him that this stone had been once a swarm of living things, of exquisite shapes and glorious colours. And yet he can plough and sow, and reap and mow, and fell and strip, and hedge and ditch, and give his neighbours sound advice, and take the measure of a man's worth from ten minutes' talk, and say his prayers, and keep his temper, and pay his debts,—which last three things are more than a good many folks can do who fancy themselves a whole world wiser than John in the smock-frock.

CORAL AND CORAL BUILDERS.

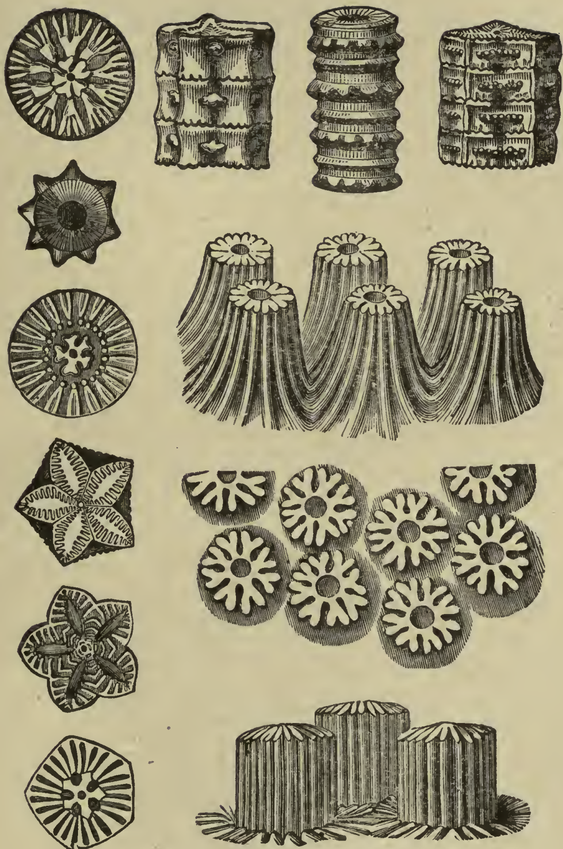
PART II.

OH, but I want to hear about the exquisite shapes and glorious colours.

Of course you do, my friend. So now for the exquisite shapes and glorious colours. I have never seen them; though I trust to see them ere I die. So what they are like I can only tell from what I have learnt from Mr. Darwin, and Mr. Wallace, and Mr. Jukes, and Mr. Gosse, and last, but not least, from one whose soul was as beautiful as his face, Lucas Barrett—too soon lost to science—who was drowned in exploring such a coral-reef as this stone was once.

Then there are such things alive now?

Yes, and no. The descendants of most of them live on, altered by time, which alters all things; and from the beauty of the children we can guess at the beauty of their ancestors; just as from the coral-reefs which exist now we can guess how the coral-reefs of old were



9 FOSSIL MADREPORES.

made. And that this stone was once part of a coral-reef the corals in it prove at first sight.

And what is a coral-reef like?

You have seen the room in the British Museum, full of corals, madrepores, brainstones, corallines, and sea-ferns?

Then fancy all those alive. Not as they are now, white stone, but covered in jelly; and out of every pore a little polype, like a flower, peeping out. Fancy them of every gaudy colour you choose. No bed of flowers, they say, can be more brilliant than the corals, as you look down on them through the clear sea. Fancy, again, growing among them and crawling over them, strange sea-anemones, shells, star-fish, sea-slugs, and sea-cucumbers with feathery gills, crabs and shrimps, and hundreds of other animals, all as strange in shape, and as brilliant in colour. You may let your fancy run wild. Nothing so odd, nothing so gay, even entered your dreams, or a poet's, as you may find alive at the bottom of the sea, in the live flower-gardens of the sea-fairies.

There will be shoals of fish, too, playing in and out, as strange and gaudy as the rest—parrot-fish who browse on the live coral with their beak-like teeth, as cattle browse on grass; and at the bottom, it may be, larger and uglier fish, who eat the crabs and shell-fish, shells and all, grinding them up as a dog grinds a bone, and so turning shells and corals into fine soft mud such as this stone is partly made of.

But what happens to all the delicate little corals if a storm comes on?

What indeed? Dame Nature has made them so well and wisely, that, like brave and good men, the more trouble they suffer the stronger they are. Day and night, week after week, the trade-wind blows upon them, hurling the waves against them in furious surf, knocking off great lumps of coral, grinding them to powder, throwing them over the reef into the shallow water inside. But the heavier the surf beats upon them, the stronger the corals outside grow, repairing their broken houses, and building up fresh coral on the dead coral below, because it is in the fresh sea-water that beats upon the surf that they find most lime with which to build. And as they build they form a barrier against the surf, inside of which, in water still as glass, the weaker and more delicate things can grow in safety, just as these very encrinites may have grown, rooted in the lime-mud, and waving their slender arms at the bottom of the clear lagoon.

Such mighty builders are these little coral polypes, that all the works of men are small compared with theirs. One single reef, for instance, which is entirely made by them, stretches along the north-east coast of Australia for nearly a thousand miles. Of this you must read some day in Mr. Jukes's "Voyage of H.M.S. *Fly*." Every island throughout a great part of the Pacific is fringed round each with its coral-reef, and there are hundreds of islands of strange shapes, and of Atolls, as they are called, or ring-islands, which are composed entirely of coral, and of nothing else.

A ring-island, you say? How can an island be made in the shape of a ring?

Ah! it was a long time before men found out that riddle. Mr. Darwin was the first to guess the answer, as he has guessed many an answer beside. These islands are each a ring, or nearly a ring, of coral, with

A RING-ISLAND.

smooth shallow water inside: but their outsides run down, like a mountain wall, sheer into seas hundreds of fathoms deep.

People used to believe, and reasonably enough, that the coral-polypes began to build up the islands from the very bottom of the deep sea. But that would not account

for the top of them being of the shape of a ring; and in time it was found out that the corals would not build except in shallow water, twenty or thirty fathoms deep at most, and men were at their wits' end to find out the riddle. Then said Mr. Darwin—

"Suppose one of those beautiful South Sea islands, like Tahiti, the Queen of Isles, with its ring of coral-reef all round its shore, began sinking slowly under the sea. The land. as it sunk, would be gone for good and all; but the coral-reef round it would not, because the coral-polypes would build up and up continually upon the skeletons of their dead parents, to get to the surface of the water, and would keep close to the top outside, however much the land sunk inside; and when the island had sunk completely beneath the sea, what would be left? What must be left, but a ring of coral-reef, around the spot where the last mountain peak of the island sank beneath the sea?"

And so Mr. Darwin explained the shapes of hundreds of coral islands in the Pacific; and proved, too, some strange things besides. He proved (and other men, like Mr. Wallace, whose excellent book on the East Indian islands you must read some day, have proved in other ways) that there was once a great continent, joined perhaps to Australia and to New Guinea, in the Pacific Ocean, where is now nothing but deep sea, and coral-reefs which mark the mountain ranges of that sunken world.

But how does the coral ever rise above the surface of the water and turn into hard stone?

TAHITI.

Of course the coral-polypes cannot build above the high-tide mark; but the surf which beats upon them piles up their broken fragments just as a sea-beach is piled up, and hammers them together with that water hammer which is heavier and stronger than any you have ever seen in a smith's forge. And then, as is the fashion of lime, the whole mass sets, and becomes hard, as you may see mortar set; and so you have a low island a few feet above the sea.

Then sea-birds come to it, and rest and build; and seeds are floated thither from far lands; and among them almost always the cocoa-nut, which loves to grow by the sea-shore, and groves of cocoa palms grow up upon the lonely isle. Then, perhaps, trees and bushes are drifted thither before the trade-wind; and entangled in their roots are seeds of other plants, and eggs or cocoons of insects; and so a few flowers and a few butterflies and beetles set up for themselves upon the new land. And then a bird or two, caught in a storm and blown away to sea, finds shelter in the cocoa-grove; and so a little new world is set up, in which (you must remember always) there are no four-footed beasts, nor snakes, nor lizards, nor frogs, nor any animals that cannot cross the sea.

And on some of those islands they may live (indeed there is reason to believe they have lived) so long, that some of them have changed their forms, according to the laws of Nature, who sooner or later fits each thing exactly for the place in which it is meant to live, till upon some

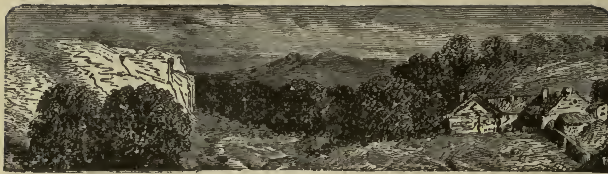
of them you may find such strange and unique forms as the famous cocoa-nut crab, which learned men call *Birgus latro.*

A great crab he is, who walks upon the tips of his toes a foot high above the ground. And because he has often nothing to eat but cocoa-nuts, or at least they are the best things he can find, cocoa-nuts he has learned to eat, and after a fashion which it would puzzle you to imitate. The sailors used to say that he climbed up the stems of the cocoa-nut trees, and pulled the fruit down for himself; but that, it seems, is not quite true. What he really does is this: when he finds a fallen cocoa-nut, he begins tearing away the thick husk and fibre with his strong claws; and he knows perfectly well which end to tear it from, namely, from the end where the three eye-holes are, which you call the monkey's face, out of one of which, you know, the young cocoa-nut tree would burst forth. And when he has got to the eye-holes, he hammers through one of them with the point of his heavy claw.

So far, so good; but how is our friend to get the meat out? He cannot put his claw in. He has no proboscis like a butterfly to insert and suck with. He is as far off from his dinner as the fox was when the stork offered him a feast in a long-necked jar. What then do you think he does? He turns himself round, he puts in a pair of his hind pincers, which are very thin, and with them scoops the meat out of the cocoa-nut, and so puts his dinner into his mouth with his hind feet. And even the cocoa-nut husk he does not waste; for he lives in

deep burrows which he makes like a rabbit, and being a luxurious crab, and liking to sleep soft in spite of his hard shell, he lines them with a quantity of cocoa-nut fibre, picked out clean and fine, just as if he was going to make cocoa-nut matting of it. And being also a clean crab, as I hope you are a clean little boy, he goes down to the sea every night to have his bath and moisten his gills, and so lives happy all his days, and gets so fat in his old age that he carries about his body nearly a quart of pure oil.

That is the history of the cocoa-nut crab. And if any one tells me that that crab acts only on what is called "instinct," and does not think and reason, just as you and I think and reason, though of course not in words as you and I do, then I shall be inclined to say that that person does not think or reason either.



CORAL AND CORAL BUILDERS.

Part III.

THEN were there many coral-reefs in Britain in old times?

Yes, many and many, again and again, some whole ages older than this, a bit of which you see, and some again whole ages newer. But see, then judge for yourself. Look at this geological map. Wherever you see a bit of blue, which is the mark for limestone, you may say, "There is a bit of old coral-reef rising up to the surface." But because I will not puzzle your little head with too many things at once, you shall look at one set of coral-reefs which are far newer than this bit of Dudley limestone, and which are the largest, I suppose, that ever were in this country; or, at least, there is more of them left than of any others.

Look first at Ireland. You see that almost all the middle of Ireland is coloured blue. It is one great sheet of old coral-reef and coral-mud, which is now called the

carboniferous limestone. You see red and purple patches rising out of it, like islands—and islands I suppose they were, of hard and ancient rock, standing up in the middle of the coral sea.

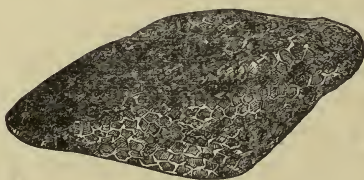
But look again, and you will see that along the west coast of Ireland, except in a very few places, like Galway Bay, the blue limestone does not come down to the sea; the shore is coloured purple and brown, and those colours mark the ancient rocks and high mountains of Mayo and Galway and Kerry, which stand as barriers to keep the raging surf of the Atlantic from bursting inland and beating away, as it surely would in course of time, the low flat limestone plain of the middle of Ireland.

But the same coral-reefs once stretched out far to the westward into the Atlantic Ocean; and you may see the proof upon that map. For in the western bays, in Clew Bay with its hundred islands, and Galway Bay with its Isles of Arran, and beautiful Kenmare and beautiful Bantry, you see little blue spots, which are low limestone islands, standing in the sea, overhung by mountains far aloft. You have often heard of those islands in Kenmare Bay talked of, and how some whom you know go to fish round them by night for turbot and conger; and when you hear them spoken of again, you must recollect that they are the last fragments of a great fringing coral-reef, which will in a few thousand years follow the fate of the rest, and be eaten up by the waves, while the mountains of hard rock stand round them still unchanged.

Now look at England, and there you will see patches

at least of a great coral-reef which was forming at the same time as that Irish one, and on which perhaps some of your schoolfellows have often stood. You have heard of St. Vincent's Rocks at Bristol, and the marble cliffs, 250 feet in height, covered in part with rich wood and rare flowers, and the Avon running through the narrow gorge, and the stately ships sailing far below your feet from Bristol to the Severn Sea. And you may see, for here they are, corals from St. Vincent's Rocks, cut and polished, showing too, that they also, like the Dudley limestone, are made up of corals and of coral mud.

Now, whenever you stand upon St. Vincent's Rocks, as



CORAL STONE.

I dare say you often will, recollect where you stand, and use your fancy, to paint for yourself a picture as strange as it is true. Fancy that those rocks are what they once were, a coral-reef close to the surface of a shallow sea. Fancy that there is no gorge of the Avon, no wide Severn Sea—for those were eaten out by water ages and ages afterwards. But picture to yourself the coral sea reaching away to the north, to the foot of the Welsh mountains; and then fancy yourself, if you will, in a

canoe, paddling up through the coral-reefs, north and still north, up the valley down which the Severn now flows, up through what is now Worcestershire, then up through Staffordshire, then through Derbyshire, into Yorkshire, and so on through Durham and Northumberland, till you find yourself stopped by the Ettrick Hills in Scotland; while all to the westward of you, where is now the greater part of England, was open sea.

You may say, if you know anything of the geography of England, "Impossible! That would be to paddle over the tops of high mountains; over the top of the Peak in Derbyshire, over the top of High Craven and Whernside and Pen-y-gent and Cross Fell, and to paddle over the Cheviot Hills, which part England and Scotland."

I know it, my child, I know it. But so it was once on a time. The high limestone mountains which part Lancashire and Yorkshire—the very chine and backbone of England—were once coral-reefs at the bottom of the sea. They are all made up of the carboniferous limestone, so called, because it carries the coal; the coal-fields usually lie upon it. It may be impossible in your eyes; but remember always that nothing is impossible with God.

But you said that the coal was made from plants and trees, and did plants and trees grow on this coral-reef?

That I cannot say. Trees may have grown on the dry parts of the reef, as cocoa-nuts grow now in the Pacific. But the coal was not laid down upon it till long afterwards, when it had gone through many and strange changes. For all through the chine of England, and in a

part of Ireland too, there lies upon the top of the lime-stone a hard gritty rock, in some places three thousand feet thick, which is commonly called "the mill-stone grit." And above that, again, the coal begins.

Now to make that 3,000 feet of hard rock, what must have happened? The sea-bottom must have sunk, slowly no doubt, carrying the coral-reefs down with it, 3,000 feet at least. And meanwhile sand and mud, made from the wearing away of the old lands in the North, must have settled down upon it. I say from the North—for there are no fossils, as far as I know, or sign of life, in these rocks of mill-stone grit; and therefore it is reasonable to suppose that they were brought from a cold current at the Pole, too cold to allow sea-beasts to live,—quite cold enough, certainly, to kill the coral insects, who could only thrive in warm water coming from the South.

Then, to go on with my story, upon the top of these mill-stone grits came sand and mud, and peat, and trees, and plants, washed out to sea, as far as we can guess, from the mouths of vast rivers flowing from the West, rivers as vast as the Amazon, the Mississippi, or the Orinoco are now; and so in long ages, upon the top of the limestone and upon the top of the mill-stone grit, were laid down these beds of coal which you see burnt now in every fire.

But how did the coral-reefs rise till they became cliffs at Bristol and mountains in Yorkshire?

The earthquake steam, I suppose, raised them. One earthquake indeed, or series of earthquakes, there was,

running along between Lancashire and Yorkshire, which made that vast crack and upheaval in the rocks, the Craven Fault, running, I believe, for more than a hundred miles, and lifting the rocks in some places a thousand feet. That earthquake helped to make the high hills which overhang Manchester and Preston and all the manufacturing county of Lancashire. That earthquake helped to make the perpendicular cliff at Malham Cove, and many another beautiful bit of scenery. And that and other earthquakes, by heating the rocks from the fires below, may have helped to change them from soft coral into hard crystalline marble as you see them now, just as volcanic heat has hardened and purified the beautiful white marbles of Pentelicus and Paros in Greece, and Carrara in Italy, from which statues are carved unto this day.

Or the same earthquakes may have heated and hardened the limestones simply by grinding and squeezing them; or they may have been heated and hardened in the course of long ages simply by the weight of the thousands of feet of other rock which lay upon them. For pressure, you must remember, always produces heat.

When you strike flint and steel together, the pressure of the blow not only makes bits of steel fly off, but makes them fly off in red-hot sparks. When you hammer a piece of iron with a hammer, you will soon find it get quite warm. When you squeeze the air together in your popgun, you actually make the air inside warmer, till the pellet flies out, and the air expands and cools again.

Nay, I believe you cannot hold up a stone on the palm of your hand, without that stone after a while warming your hand, because it presses against you in trying to fall, and you press against it in trying to hold it up. And recollect above all the great and beautiful example of that law which you were lucky enough to see on the night of the 14th of November, 1867, how those falling stars were coming out of boundless space, colder than any ice on earth, and yet, simply by pressing against the air above our heads, they had their motion turned into heat, till they burned themselves up into trains of fiery dust.

So remember that wherever you have pressure you have heat, and that the pressure of the upper rocks upon the lower is quite enough, some think, to account for the older and lower rocks being harder than the upper and newer ones.

But why should the lower rocks be older and the upper ones newer? You told me just now that the high mountains in Wales were ages older than Windsor Forest upon which we stand: but yet how much lower we are here than if we were on a Welsh mountain!

Ah, my dear child, of course that puzzles you, and I am afraid it must puzzle you still till we have another talk; or rather it seems to me that the best way to explain that puzzle to you would be for you and me to go a railroad journey into Wales, and look into the matter for ourselves; and from here to Wales we will go, either in fancy or on a real railroad, before we have another talk about these things.

Now it is time to stop. Is there anything more you want to know? for you look as if something was puzzling you still.

Were there any men in the world while all this was going on?

I think not. We have no proof that there were not, but also we have no proof that there were; the cave-men, of whom I told you, lived many ages after the coal was covered up. You seem to be sorry that there were no men in the world then.

Because it seems a pity that there was no one to see those beautiful coral-reefs and coral-forests.

No one to see them, my child? Who told you that? Who told you there are not and never have been any rational beings in this vast universe, save certain weak, ignorant, short-sighted creatures shaped like you and me?

But even if it were so, and no created eye had ever beheld those ancient wonders, and no created heart ever enjoyed them, is there not One Uncreated who has seen them and enjoyed them from the beginning? Were not these creatures enjoying themselves each after their kind? And was there not a Father in heaven who was enjoying their enjoyment, and enjoying too their beauty, which He had formed according to the ideas of His Eternal Mind? Recollect that this world was not made for man alone; but that man, and this world, and the whole universe were made for God; for He created all things, and for His pleasure they are, and were created.

NATURE AND HER TOOLS.

NATURE AND HER TOOLS.

DURING the recent past, we have had gigantic buildings devoted to the display of a variety of machines admirably designed to diminish human toil; and an infinite diversity of tools and implements, more or less adapted to facilitate the labour of the mechanic.

It cannot but be interesting to compare with these the mechanical contrivances of nature, which far exceed them in ingenuity and completeness.

We will begin with some of the simplest illustrations of these.

One of the most useful implements of the artisan is the *saw*, with which he is enabled to cut in pieces the hardest timber or stone.

The principle upon which the saw is constructed is familiar to every one, but in order the better to understand the difference between the saws of nature and those of art, it may be as well to remind the reader what that principle is: saws of human manufacture are made

of the hardest steel, their cutting edge is divided into sharp teeth pointing in the same direction, by means of which the fibres of the wood are torn into minute pieces, and thus solid timber is gradually worn through.

The saw made use of by the human artisan is but a bungling contrivance when compared with those employed in the economy of nature.

The saw-fly, one of a remarkable race of insects, as a means of preserving its eggs from destruction, and of providing a proper supply of food for the young to which they give birth, is instructed to deposit its eggs in the leaves or tender shoots of the growing branches of trees. To enable it to effect this, the female saw-fly is provided with a very remarkable apparatus, which consists of two saws, placed back to back, and so arranged that they can alternately be pushed forward and backward. One only of these saws is first driven forward, and, while it is retracted, its fellow is pushed out, and this is continued until an aperture of sufficient size has been made.

These saws, however, are not only furnished with teeth at their edge, but have smaller ones distributed over their whole surface, so that they perform the office of files as well as saws, and not only cut a slit in the wood, but enlarge the opening until it is sufficiently capacious to receive the eggs into its interior. To protect this delicate instrument when not in use, it is enclosed in a case formed by two hinged flaps, one on each side of the saw.

The eggs, deposited with so much skill, are not left to

chance. Immediately after the puncture has been made, the part of the stalk around it begins to swell, and an excrescence is formed, such as we frequently see on the stem of a rose-tree, or the leaf of a willow. In a few days the eggs produce young grubs, which, after undergoing a change into a chrysalis state, finally assume the form of their parent, a four-winged fly.

It is related of the female of one kind of saw-fly, that

LARVA OF SAW-FLY.

she will remain on the leaf within which she has deposited her eggs till they are hatched, that she feeds them carefully, and resting with her wings stretched over them, protects them from the heat of the sun, or from the attacks of enemies; and that she continues to do so for several weeks, until her young ones no longer require her maternal care.

A still more wonderful piece of instinct is exhibited by the ichneumons or cuckoo-flies, a race of insects to whom is entrusted an important department in the police of nature.

The common butterfly will lay, perhaps, 500 eggs in the course of a single summer; and, although butterflies themselves are not generally regarded as dangerous enemies, a very little reflection will show, that if not rigidly watched over they would become exceedingly formidable. The butterfly, be it remembered, produces as its progeny, not butterflies like the parent animal, but active, hungry caterpillars, with ravenous appetites and horny jaws.

If, therefore, a garden was, at any time during a single season, visited by 500 of these pretty flutterers, which is by no means improbable, the consequence would be a progeny of 25,000 caterpillars; a number obviously quite sufficient to cause serious injury to the garden. If each of these in its turn was to lay 500 eggs, it is evident that the country would soon be rendered uninhabitable by the overwhelming increase of butterflies.

On the other hand, it is equally obvious that if the supply of caterpillars was to be diminished to any considerable extent, vast numbers of birds and other animals would be deprived of food. The consequences under either supposition would be equally detrimental to the harmony of Nature. The agents employed by the Creator to insure an adequate supply of caterpillars, and,

at the same time, to prevent a too rapid multiplication of butterflies, are the little ichneumons above alluded to.

The apparatus employed for this purpose resembles an *awl*, the end of which is flattened and sharp. By the assistance of this the cuckoo-fly is enabled to deposit her eggs in the back of the caterpillar, which, unconscious of its injury, feeds and enjoys its life, regardless of the

SIREX GIGAS.

brood of young ichneumons feeding upon the very nutriment on which it is dependent for its existence. It lives on apparently unharmed, but when the time arrives for undergoing its metamorphosis, too feeble to make the usual change into a chrysalis, it dies.

There is one insect, the *Sirex Gigas*, which may fairly be called a worker in metals. This insect is furnished with *drills* by which it can drill through lead. It is related

that it actually drilled through the balls in the cartridges of the French troops in the Crimea.

Shears and *scissors* it might naturally be supposed would require human hands to guide them, but long before mankind possessed such useful instruments, they were busily at work in the depths of the sea, and that with as unerring fatality as the fabled shears of Atropos.

The rocks and grottoes of the ocean are as richly carpeted with a verdure of their own, as our hills and valleys. Seaweeds and corallines, exquisite in colour and beautiful in form, clothe them in rich profusion. But though away from the view of man or of those animals with whom he is more familiar, there are creatures formed to revel in this luxuriant growth, and to whom it affords a continual banquet. The Tritonea, a kind of marine slug, is one of these, and it is furnished with scissors to clip off the living flowers which serve it for sustenance.

The mouth of the Triton is of a most singular construction. Enclosed within two fleshy lips which form the external part of this organ, lie two flat horny jaws, united at one end by an elastic joint; a strong muscle brings together the sharp jaws, which pass one over the other like the blades of shears, and are enclosed again by the spring which connects them. Within this destructive mouth is a tongue covered with sharp hooks, all bent in the direction of the throat, to which they convey the ample supply of food prepared by the jaws.

One of the most useful of the tools of the carpenter

is a *chisel*, and efficiently enough it does its work, so long as it can be kept sharp; but even with the utmost care it is apt to become dull and blunted. Could some ingenious mechanician produce a set of these useful instruments, that would always retain a sharp cutting edge, and never need grinding, they would certainly be classed among the most ingenious and useful inventions.

Now in the animal creation such sets of tools are constantly at work, in the mouth of every rat and mouse and squirrel. Hour after hour will a rat continue its patient gnawing at the hardest board; day after day, and week after week, will it pursue the same employment; and yet its teeth never appear to be worn in the least. We say appear, because this constant gnawing does wear away even the teeth of a rat, but provision has been made for this constant attrition. The teeth of the Rodents, or gnawing animals, never cease growing. Fresh matter is added from behind to the tooth, as it is gradually pushed up in front, and thus no obvious diminution of size takes place.

Still it would seem impossible but that the sharp edge should become blunted, even though the tooth should retain its proper length. So it would be, indeed, were the tooth of the same material throughout. But these gnawing teeth are formed of two different substances. The bulk of the tooth is of ivory, which of itself would not be hard enough for the work that has to be done Its front is therefore covered with a thin plate of enamel,

extremely hard and durable, and as this wears away much more slowly than the ivory, a sharp cutting edge is always maintained.

But in order to estimate properly the efficiency of these chisels of Nature's contrivance, we ought to know what amount of work they are capable of performing, and of this the structures erected by the beavers will give us some idea.

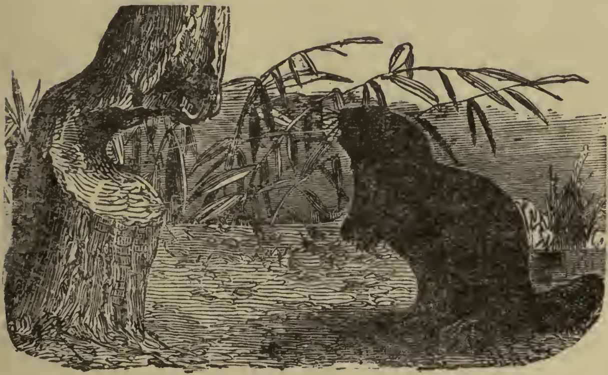
These industrious creatures have long been celebrated for their skill in erecting their dwelling; but though our readers are already acquainted with their manner of building, it may not be superfluous briefly to recount it.

The beavers, who always work in companies, assemble together in the months of June and July to establish their settlement. They congregate in numbers of two or three hundred on the bank of some river, and the place of meeting is usually the spot on which they commence their operations. The object of these united labours is twofold; first, to form a species of pond in which the water may be always retained at the same height; and secondly, to construct an assemblage of secure dwellings for the whole colony of labourers.

On the bank of some running stream, at a part where the water is shallow, and shaded by poplars or overhanging willows, these four-footed engineers begin their work. Their first object is to select some large tree conveniently overhanging the river, and, seating themselves around it in sufficient number, they begin to cut it

down with their sharp chisel-like teeth, enjoying meanwhile the morsels of fresh wood and tender bark, which are their favourite food.

The tree, although often as thick as a man's body, is soon cut down by their joint efforts; it falls across the stream, and forms the principal beam in their building. They cut the branches from the top to make it lie evenly,



BEAVER AT WORK.

while others fell trees of smaller girth, and divide them into stakes of a proper length. These they convey to the edge of the river, and then bring them by water to their building-place. There they have to begin the task of pile-driving, without the mechanical contrivances to which human engineers have recourse.

With their ever-ready teeth some of the beavers uplift the stakes and drive them into holes, which others of

their party, plunging below the water, have already made for their reception. Many rows of these piles are driven, and the intervening spaces filled up with branches, which the intelligent creatures weave in between them. Others go in search of earth, which they beat with their tails, and temper with their feet until it is of a proper consistence to fill up all the crevices in their building.

The dam erected in this manner across the river is a construction of no small labour, being often from eighty to one hundred feet long, and from eight to ten feet wide. It is formed of numerous piles of equal height, planted close together. These piles, which are perpendicular on the outer side of the dam, are placed in a sloping direction on the inner side; thus giving all the solidity necessary for supporting the weight of the water, and for preventing its overthrow.

On this dam, the top of which is flat and smooth, the beaver village is erected, the huts of which it consists are sometimes ten feet in diameter, having walls two feet in thickness, which are usually built to the height of a few feet, and then covered in by a vaulted roof. Sometimes a second, or even a third, storey is added.

These huts have each two apertures, one of which gives admission from the general causeway, and the other a window looking upon their pond. It sometimes happens that the water is frozen over below the level of their window, and their entrance to the bathing-place precluded. In this case, they make another opening beneath the ice; for access to the water is essential to their

well-being. The houses are neatly plastered throughout with mortar, which they beat and temper with their feet. Here another remarkably well-adapted tool comes into requisition. To assist them in their work, they have been provided with a most excellent *trowel;* the tail of the beaver is flat, and covered with scales; with this they plaster the walls of their houses, to render them quite impervious to rain, and effect it with such mason-like skill, that it is difficult to imagine that human hands have not been employed in the work.

Each hut serves for the abode of several pairs of beavers; and close to each dwelling is a store-house for the food of the family. This consists of stems and branches of trees cut into short lengths. The beavers have only recourse to this stock when fresh green wood, their favourite aliment, cannot be procured.

Thus furnished with commodious habitations and a plentiful supply of provisions, the beavers pass a happy and a busy life. Great care is taken to keep their village and the dam upon which it is built, in good repair, and general harmony prevails.

Part of their time is passed in the water, and for this they have been well fitted by nature. Their hinder feet, which serve as *oars* to row them along in the water, are webbed, and their broad flat tails serve as a *rudder* to direct their course, and thus these singular quadrupeds are enabled to occupy a situation in which an animal without such various adaptations would not be able to exist.

To creatures so circumstanced the possession of chisel-like teeth, which no wear can blunt, is obviously indispensable; and it would be difficult to imagine any contrivance more perfect than that adopted to secure the lasting efficiency of the inimitable tools with which they are furnished.

NATURE AND WHAT IS SMALL

NATURE, AND WHAT IS SMALL.

AN eminent naturalist observes that the telescope teaches us that every world is an atom, and the microscope that every atom is a world.

What does *small* mean in nature?

The question was suggested to the mind of a German naturalist while investigating into the inconceivable multitudes of microscopical organic forms entering into the constitution of the chalk formation.

This geological system extends over a vast portion of the globe; and modern observation has proved that, probably to the amount of fully one-half, it consists of the remains of animals which were deposited at the bottom of a primeval ocean. Many of the remains are those of shell-fish, sea-urchins, zoophytes, and other animals; but by much the largest proportion of the formation is composed of the shells of minute animalculæ, only discernible by the microscope. The mind is overwhelmed by the idea of the myriads of animated atoms which have con-

tributed by their remains to build up masses of chalk, constituting mountain chains in Europe, Asia, Africa, and America.

The purer forms of common white chalk exhibit, under the microscope, an aggregation of shells, corals, and

THE ORGANISMS WHICH FORM COMMON CHALK—KNOWN AS FORAMINIFERA, GREATLY MAGNIFIED.

other structures, of which a million individuals are contained in a cubic inch of the substance. A hundred thousand of these minute shells are computed to enter into the constitution of the chalk employed in enamelling an ordinary visiting card.

They are chiefly the shells of a group of animals, of extremely simple organization, named *Foraminifera.* The body of the animal consists of little else than an atom of thin transparent glair or jelly. It begins life by constructing a shell of one chamber; but in proportion as the size of the body exceeds that of its tiny dwelling, it adds one chamber after another, corresponding to its growing dimensions, till it finally settles in its mature state in the outermost and roomiest cavity of the series.

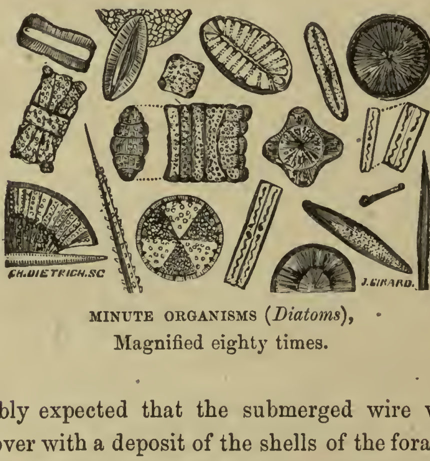
The nummulite characterizing immense beds of calcareous rock in the Alps and Pyrenees, and also the limestone constituting the foundation of the Great Pyramid of Egypt, and forming the principal mass of the huge body of the Sphinx, is one of the largest species of the order. It derives its name from its similarity to a coin; and the legend has lingered in Egypt since the time of Strabo, that the nummulites of the pyramids, familiar to all travellers in that country, are the lentils upon which the builders fed while rearing those imperishable edifices, and which, in the progress of time, have been converted into stone.

But in general the shells of the foraminifera are of excessive minuteness.

The rocks upon which the city of Paris rests are composed almost wholly of these shells, which are packed together as closely as the grains in a heap of turnip-seed; and the houses of the capital are built of the same curious organism.

Existing sea-bottoms appear to be covered to unknown

depths by recent species of foraminifera. When the officers of the ship *Dolphin* were sounding the bed of the Atlantic for the electric telegraph, the matter brought up by the lead from a depth of two thousand fathoms in mid-ocean was found to be composed entirely of the shells of these animalculæ, without any admixture of unorganized or merely earthy substances. It was, therefore,



MINUTE ORGANISMS (*Diatoms*),
Magnified eighty times.

reasonably expected that the submerged wire would be coated over with a deposit of the shells of the foraminifera, and thus become permanently protected against danger from friction by oceanic currents within the space of three years. An ounce of sand obtained from the Caribbean Sea was estimated to contain the amazing number of 3,840,000 shells.

The German investigation of the organisms of the chalk took an illustration from the blasting of the cliff at

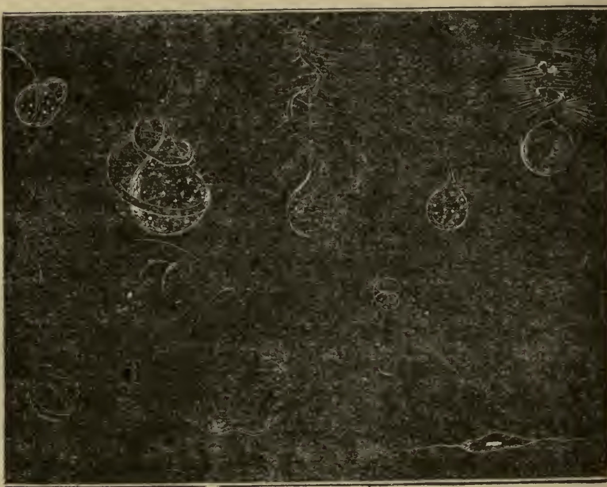
Dover for the railway, in 1843. Years of labour were expended in preparing shafts and galleries, and the largest charge of gunpowder ever employed was fired by a powerful galvanic battery. A million of tons of the chalk rock were torn away in a minute, almost silently, and a surface of nearly fifteen acres was covered twenty feet deep with its fragments.

"And with what," says the writer, "did the power of the human mind enter into this giant struggle? With the remains of creatures, a thousand of which might be annihilated by the pressure of a finger! We wonder, and ask ourselves, *What does* SMALL *mean in nature?*"

The Bergmehl, or mountain-meal of the north of Europe, used in Sweden and other countries as an article of food, was found by Ehrenberg to consist of the shells of minute animals, which had been deposited in water at a remote period, but the exuviæ of which still retained sufficient animal matter to render them nutritive when mixed with flour. Till this discovery was made by the most ingenious of microscopists, the mountain-meal was considered to afford an exception to the universal fact, that the mineral kingdom is incapable, directly, of yielding food for animals.

Another vast group of minute organisms inhabit the debateable region between the animal and the vegetable kingdom. Zoologists and botanists long did battle for possession of this border territory, which, being often taken and retaken, may, at length, be considered to

be finally established as a province of the kingdom of plants, the inhabitants being distinguished by the name of the *Diatomaceæ*. The diatom (or brittle-wort) is a plant consisting of a single cell, yet it represents the fundamental principle of the most complex vegetable structures, and illustrates the uniformity of the plan of



MICROSCOPIC PLANT LIFE.

organization in the vegetable kingdom; for the sturdy oak, the patrician palm, and the peerless Wellingtonia of the Californian forest is each an aggregation of cells.

Unlike the delicate calcareous shells of the animals previously described, the coverings of these unicellular plants are siliceous and indestructible. It is, indeed,

only after their separation from the substances containing them, by exposure to the action of the strongest heat and the fiercest chemical acids, that they are produced in all their crystalline brilliancy and purity, and are fit for being mounted on shells as microscopic objects.

The cell multiplies by spontaneous sub-division, a process which proceeds in a geometrical ratio, and often with great rapidity. The progeny of a single individual, on the moderate calculation that each successive act of self-division takes place every twenty-four hours, would amount in a month to one thousand millions!

Some species inhabit the sea, others are found only in fresh water. The favourite habitats of many species are the stones of mountain streams and water-falls. Shallow pools, and mouths of rivers, roadside ditches, water-troughs, and cisterns, abound with various species. Ehrenberg has found them alike in the oldest and the newest fossiliferous rocks. Darwin witnessed them drifting in clouds from the continent of America to that of Africa, and coming in contact with the sails of the ship in which he was a voyager. Dr. Hooker discovered them in myriads in the ice within the Antarctic circle; and the same observer, on examining the mud brought up by the lead on sounding a bank on the flanks of Victoria Land, not less than 400 miles long, and 120 broad, and of a depth which could not be conjectured, ascertained that it was almost entirely composed of the remains of diatoms.

No description can convey an adequate idea of the

symmetry and beauty displayed in the forms of these crystalline atoms. The infinitesimally minute striations and sculptures on the surface of many species, task the highest powers of the optician's glass.

Like the higher tribes of plants, the diatoms give off oxygen gas, under the influence of the sun's light and heat; the result, doubtless, of the decomposition of carbonic acid gas, which all vegetables abstract from the air.

They are thus rendered instrumental in maintaining the atmosphere in a state of purity and salubrity for the respiration of animals. A still more important function is performed by the lower tribes both of animals and plants. Occupying a position on the very verge of organized being, they are employed to prevent the tendency of decomposing animal and vegetable matter to pass into the gaseous state, and return to the inorganic world.

"These wakeful members of Nature's invisible police," to use the words of Professor Owen, "are everywhere ready to arrest the fugitive organized particles, and turn them back into the ascending stream of life."

USE OF THE EYES.

USE OF THE EYES.

WHEN I was the age of my boy and girl readers, there were no such reading-books as there are now. Those which we had were few and dull, and the pictures in them ugly and mean; while you have your choice of books without number, clever, amusing, and pretty, as well as really instructive, on subjects which were only talked of, fifty years ago, by a few learned men, and very little understood even by them.

So if mere reading of books would make wise men, you ought to grow up much wiser than us old fellows. But mere reading of wise books will not make you wise men: you must use for yourselves the tools with which books are made wise; and that is—your eyes, and ears, and common sense.

Now, among those very stupid old-fashioned boys' books was one which taught me that; and therefore I am more grateful to it than if it had been as full of wonderful pictures as all the natural history books you ever saw.

Its name was "Evenings at Home;" and in it was a story called "Eyes and No Eyes;" a regular old-fashioned, prim, sententious story; and it began thus:—

"Well, Robert, where have you been walking this afternoon?" said Mr. Andrews to one of his pupils, at the close of a holiday.

Oh—Robert had been to Broom Heath, and round by Camp Mount, and home through the meadows. But it was very dull. He hardly saw a single person. He had much rather have gone by the turnpike-road.

Presently in comes Master William, the other pupil—dressed, I suppose, as wretched boys used to be dressed forty years ago, in a frill collar, and skeleton monkey-jacket, and tight trousers buttoned over it and hardly coming down to his ankles, and low shoes which always came off in sticky ground; and terribly dirty and wet he is; but he never, he says, had such a pleasant walk in his life, and he has brought home his handkerchief (for boys had no pockets in those days much bigger than keyholes) full of curiosities.

He has got a piece of mistletoe, and wants to know what it is; and he has seen a woodpecker, and a wheat-ear, and gathered strange flowers on the heath; and hunted a pee-wit because he thought its wing was broken, till, of course, it led him into a bog, and very wet he got. But he did not mind it, because he fell in with an old man cutting turf, who told him all about turf-cutting, and gave him a dead adder. And then he went up a hill, and saw a grand prospect; and wanted to go again, and make out

the geography of the country from Cary's old county maps, which were the only maps in those days. And then, because the hill was called Camp Mount, he looked for a Roman camp, and found one; and then he went down to the river, and saw twenty things more; and so on, and so on, till he had brought home curiosities enough, and thoughts enough, to last him a week.

Whereon Mr. Andrews, who seems to have been a very sensible old gentleman, tells him all about his curiosities. And then it comes out—if you will believe it—that Master William has been over the very same ground as Master Robert, who saw nothing at all.

Whereon Mr. Andrews says, wisely enough, in his solemn, old-fashioned way—

"So it is. One man walks through the world with his eyes open, another with his eyes shut; and upon this difference depends all the superiority of knowledge which one man acquires over another. I have known sailors who have been in all the quarters of the world, and could tell you nothing but the signs of the tippling houses, and the price and quality of the liquor. On the other hand, Franklin could not cross the Channel without making observations useful to mankind. While many a vacant, thoughtless youth is whirled through Europe without gaining a single idea worth crossing the street for, the observing eye and inquiring mind find matter of improvement and delight in every ramble. You then William, continue to use your eyes. And you, Robert, learn that eyes were given to you to use."

So said Mr. Andrews: and so I say to you.

Therefore I beg all good boys and girls among you to think over this story, and settle in their own minds whether they will be Eyes or No Eyes; whether they will, as they grow up, look, and see for themselves what happens; or whether they will let other people look for them, or pretend to look; and dupe them, and lead them about—the blind leading the blind, till both fall into the ditch.

I say "good boys and girls;" not merely clever boys, or prudent boys; because using your eyes or not using them is a question of doing right or doing wrong.

God has given you eyes, and it is your duty to God to use them. If your parents tried to teach you your lessons in the most agreeable way, by beautiful picture-books, would it not be ungracious, ungrateful, and altogether naughty and wrong, to shut your eyes to those pictures, and refuse to learn?

And is it not altogether naughty and wrong to refuse to learn from your Father in heaven, the Great God who made all things, when He offers to teach you all day long by the most beautiful and most wonderful of all picture-books, which is, simply all things which you can see, and hear, and touch, from the suns and stars above your heads, to the mosses and insects at your feet? It is your duty to learn His lessons: and it is your interest likewise. God's Book, which is the Universe, and the reading of God's Book, which is Science, can do you nothing but good, and teach you nothing but truth and wisdom.

God did not put this wondrous world about your young souls to tempt or to mislead them. If you ask Him for a fish, He will not give you a serpent. If you ask Him for bread, He will not give you a stone.

So use your eyes and your intellect, your senses and your brains, and learn what God is trying to teach you continually by them. I do not mean that you must stop there, and learn nothing more; anything but that.

There are things which neither your senses nor your brains can tell you; and they are not only more glorious, but actually more true, and more real, than any things which you can see or touch. But you must begin at the beginning in order to end at the end; and sow the seed if you wish to gather the fruit.

God has ordained that you, and every child which comes into the world, should begin by learning something of the world about him by his senses and his brain; and the better you learn what they can teach you, the more fit will you be to learn what they cannot teach you. The more you try now to understand *things*, the more you will be able hereafter to understand men, and That which is above men. You begin to find out that truly Divine mystery, that you had a mother on earth, simply by lying soft and warm upon her bosom: and so (as our Lord told the Jews of old) it is by watching the common natural things around you, and considering the lilies of the field, how they grow, that you will begin at last to learn that far Diviner mystery—that you have a Father in heaven.

And so you will be delivered (if you will) out of the

tyranny of darkness, and distrust, and fear, into God's free kingdom of light, and faith, and love; and will be safe from the venom of that tree, which is more deadly than the fabled Upas of the East.

Who planted that tree I know not, it was planted so long ago: but surely it is none of God's planting, neither of the Son of God: yet it grows in all lands, and in all climes, and sends its hidden suckers far and wide—even (unless we be watchful) into your hearts and mine.

Its name is the Tree of Unreason, whose roots are conceit and ignorance, and its juices folly and death.

It drops its venom into the finest brains, and makes them call sense nonsense, and nonsense sense; fact fiction, and fiction fact.

It drops its venom into the tenderest hearts, alas! and makes them call wrong right, and right wrong; love cruelty, and cruelty love.

Some say that the axe is laid to the root of it just now, and that it is already tottering to its fall; while others say that it is growing stronger than ever, and ready to spread its upas-shade over the whole earth. For my part, I know not, save that all shall be as God wills. The tree has been cut down already, again and again, and yet has always thrown out fresh shoots, and dropped fresh poison from its boughs. But this at least I know, that any little child who will use the faculties which God has given him, may find an antidote to all its poison in the meanest herb beneath his feet.

There—you do not understand me, my boys and girls:

and the best prayer I can offer for you is, perhaps, that you should never need to understand me: but if that sore need should come, and that poison should begin to spread its mist over your brains and hearts, then you will be proof against it, just in proportion as you have used the eyes, and the common sense which God has given you, and have considered the lilies of the field, how they grow.